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Strategic surveys of seabirds off the west coast of Lewis to determine use of seaspace in areas of potential marine renewable energy developments

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This report presents the results of marine and freshwater scientific work carried out for Marine Scotland under external commission.

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Project: Strategic surveys of seabirds off the west coast of Lewis to determine use of seaspace in areas of potential marine renewable energy developments	
Report: 2012 & 2013 survey results	
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1. Executive summary

1.1 By 2020 the percentage of Scotland's energy coming from renewable sources will increase. Studies have identified that there is a need to research how offshore renewable developments affect wildlife populations. The surveys presented here will help to find out how one area of marine development, the west coast of Lewis, is used by waterbirds and marine mammals. Areas close to the Isle of Lewis have already been identified as being important for these groups of animals, through the Special Protection Areas (SPA) network.

1.2 Methods used during these surveys included a desk-based study, a digital aerial survey and ground-based counts. The digital aerial survey involved an aircraft flying systematic 2km spaced transects through the survey area recording high definition video along four 200m strips thus achieving 10% sampling coverage of the area. The images recorded were processed, and bird and mammal species were identified by analysts post survey and strip transect analysis undertaken to derive abundance estimates for the study area. Density surface modelling was undertaken for fulmars, gannets and auk species.

1.3 Ground-based counts involved an ornithologist undertaking a bird and marine mammal survey from 14 vantage points along the west coast of Lewis. These counts were co-ordinated as much as possible with the aerial survey, and were used to gain more information about more difficult to identify species, or undertaken in places known to be important for seabirds but likely to be missed by the aerial survey. A further vantage point study covering the majority of Loch Roag was also undertaken, covering areas outside the aerial survey study area.

1.4 Aerial and coastal ground-count surveys were undertaken in April, June, July, September and December 2012 and February 2013 with additional surveys of Loch Roag in April, June, July and October 2012 and January and February 2013.

1.5 In April the digital aerial survey recorded 792 birds and 11 mammals from 31 species and species groups. Fulmars were the most abundant bird. In May 347 birds from 24 species and species groups were recorded, with Fulmar again the most abundant bird. In June 491 birds, 24 mammals and one shark were counted, from 41 species and species groups. Fulmars again had the highest count. In July, 525 birds, 15 mammals and one shark were recorded, from 36 species and species groups. In this month gannets were the most numerous bird species. Gannets were again the most commonly recorded bird in September with 247 recorded out of 494 bird records of 25 species or species groups. Five basking sharks were recorded in September, together with eight other marine mammal records. Fulmars were again the most commonly recorded bird species in December 2012 and February 2013 with 133 and 186 records out of 410 and 589 bird records from 22 and 23 species or species groups respectively. The only marine mammals recorded in December and February were two and one harbour porpoises respectively.

1.6 From the west coast of Lewis ground-based counts, a total of 122 birds were counted in April, from 19 species and species groups, in May 145 birds were

counted from 18 species and species groups. In June 245 birds and seven mammals from 24 species and species groups were recorded. Recorded bird activity declined in July with 111 birds, three mammals and one shark counted in total, from 21 species and species groups. Fulmars and auks were commonly the most numerous birds counted. 315 birds of 10 species and species groups and eight grey seals and a basking shark were recorded in September, 247 birds of 11 species or species groups were recorded in December with no mammals and the busiest survey was in February 2013 with 655 birds of 12 species or species groups and one grey seal.

1.7 Overall numbers of birds recorded from the aerial and ground counts were low in comparison to numbers of these species breeding on colonies within foraging range.

1.8 Thirty eight species of bird were recorded from the six Loch Roag surveys, including six species of high conservation importance and small numbers of harbour seal and grey seals.

1.9 A comparison of the aerial and ground counts was undertaken. Small sample sizes precluded detailed statistical analysis and the identification of conclusive trends, although some general trends were identified. These included more diving birds such as shags, divers, and auks, particularly black guillemots recorded during ground counts than by aerial surveys, due partly to them spending a proportion of their time underwater in dives and thus unavailable for counting by the almost instantaneous aerial surveys.

2. Introduction

Project background

2.1 The Scottish Government has met its target to generate 31% of Scotland's electricity demand from renewable sources by 2011 and has now set new targets of 50% of electricity demand by 2015 and 100% by 2020 using renewable sources. This will be achieved through a balanced portfolio of both offshore and onshore technologies including wave and tidal devices. The west coast of Lewis has some of the best marine energy resources in the country and has been identified as a potential location for a number of wave and tidal energy devices.

2.2 As identified in the 2007 Marine Renewables Strategic Environmental Assessment (SEA) there is a need to identify and evaluate potential interactions between offshore renewable developments and marine wildlife and habitats.

2.3 Though some data are available regarding the marine wildlife found on and around the Isle of Lewis, data regarding the use of the marine areas by seabirds and marine mammals are incomplete and additional data are required to understand how the area is used by wintering and breeding seabird populations and marine mammals.

2.4 The aim of this project is to establish how seabird and marine mammal populations are distributed in relation to the areas of interest for wave and tidal renewable energy devices through the use of digital aerial surveys and ground vantage point surveys.

Sensitivity of seabird and marine mammal populations to wave and tidal devices

2.5 The potential impacts of offshore marine energy devices on seabirds and marine mammals can be categorised as collision causing direct or indirect mortality, displacement due to construction, maintenance or operational disturbance or habitat loss, and barrier effects where device arrays are, or are perceived to be, impassable obstacles (RSPB 2012).

2.6 Diving birds are considered to be potentially sensitive to the deployment of tidal stream and wave devices (WWT Consulting 2010, Smith *et al*. 2011, and Furness *et al*. 2012).

2.7 Furness *et al*. (2012) identified black guillemots *Cepphus grylle*, razorbills *Alca torda*, shags *Phalacrocorax aristotelis*, guillemots *Uria aalge*, cormorants *Phalacrocorax carbo*, diver species *Gavia spp*. and puffins *Fratercula arctica* as the species most vulnerable to negative impacts from tidal renewable energy turbines in Scottish waters due mainly to their pursuit diving strategy for finding and catching prey underwater.

2.8 Similarly Wilson *et al*. (2007) identified all regularly occurring marine mammals as potentially at high risk from underwater renewable energy devices due to

their spending the majority of their lives underwater and even those benthic feeders passing through the water column to the surface to breathe.

Ornithological and marine mammal interest around the west coast of Lewis

Ornithology

2.9 The Isle of Lewis, along with the other islands in the Outer Hebrides, is an important area for breeding seabirds with a number of Special Protected Areas (SPAs) designated in accordance with the Birds Directive (Directive 2009/147/EC) because of the presence of internationally important seabird assemblages and breeding populations.

2.10 The Isle of Lewis itself contains the Lewis Peatlands SPA and Ramsar site, an important breeding area for black-throated divers *Gavia arctica* and red-throated divers *G. stellata*. While these species breed on freshwater sites within the SPA they will also forage and winter in coastal areas. Other SPAs adjacent to the Isle of Lewis include the Flannan Isles (west of the island) and the Shiant Isles (east of the island) both of which hold important assemblages of breeding seabirds with 50,000 and 200,000 individual seabirds respectively (Joint Nature Conservation Committee 2011a). These islands hold important populations of fulmars *Fulmarus glacialis*, shags, Leach's storm-petrels *Oceanodroma leucorhoa*, kittiwakes *Rissa tridactyla*, guillemots, razorbills and puffins.

2.11 In the surrounding area there are a number of other SPAs which include seabirds as part of their designation. To the south west the St. Kilda archipelago has approximately 600,000 seabirds breeding including over 50,000 pairs of gannets and 155,000 pairs of puffins. To the south the Monach Islands hold breeding populations of common terns *Sterna hirundo*, little terns *Sterna albifrons*, razorbills and black guillemots along with another large assemblage of breeding seabirds.

2.12 The west coast of Lewis is within mean-maximum foraging range (Thaxter *et al*. 2012) for: fulmars, Leach's storm-petrels, kittiwakes, guillemots, razorbills and puffins from the Flannan Isles SPA; fulmars, European storm-petrels *Hydrobates pelagicus*, Leach's storm-petrels, gannets *Morus bassanus*, guillemots and puffins from North Rona and Sula Sgeir SPA; fulmars, guillemots and puffins from the Shiant Isles SPA; fulmars, gannets and puffins from St. Kilda SPA; fulmars, kittiwakes and guillemots from Handa SPA; and fulmars, guillemots and puffins from Cape Wrath SPA, with the highly mobile fulmars and gannets in theory being able to reach the study area from any Scottish breeding colony.

Marine mammals and sharks

2.13 The Outer Hebrides are probably the richest area of the UK for marine mammals with around 20 species of cetacean recorded in the region over the last 30 years and hold important breeding areas for both harbour seals *Phoca vitulina* and grey seals *Halichoerus grypus*.

2.14 All cetacean species are currently offered 'strict protection' under the EU Habitats Directive.

2.15 Harbour porpoises *Phocoena phocoena* are the most widespread and commonly recorded cetacean species around the Outer Hebrides year round, particularly in the Sound of Barra, around the Monarch Islands and inlets around the Isle of Harris (Evans 2000, Reid *et al*. 2003). There are more records of this species from the summer (June to September) from the Outer Hebrides, but whether this reflects actual abundance or sampling bias is unclear (Reid *et al*. 2003) Harbour porpoises are protected under Annex II of the Bern Convention and Annex II of the EU Habitats and Species Directive (1992). It is included on the Oslo and Paris Convention (OSPAR) first list of threatened and declining species and is also protected under The Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) which applies to all odontocetes (toothed whales and dolphins) except sperm whale. Signatories are obliged to apply conservation, research and management measures prescribed in its Annex to all species.

2.16 White-beaked dolphins *Lagenorhynchus albirostris* are commonly seen in waters of the Outer Hebrides with concentrations of sightings around the northern point of the Isle of Harris and around Isle of Lewis (Evans, 2000, Reid *et al*. 2003). The majority of sightings are made between July and September (Evans, 2000). This species is protected by the Wildlife and Countryside Act 1981, ASCOBANS and the Bonn Convention. They are also included on Annex IV of the EC Habitats Directive.

2.17 Risso's dolphins *Grampus griseus* are widespread around the Outer Hebrides. They are most commonly sighted in the north east of the islands around the Eye Peninsula, Lewis and the inshore waters of the Isle of Harris, with most records made between May and September (Evans, 2000, Reid *et al*. 2003). Risso's dolphin is protected under appendix II of both the Bern and Bonn Conventions. It is also protected under appendix IV of the EU Habitats and Species Directive (1992). As with the harbour porpoises, Risso's dolphins are also covered by ASCOBANS.

2.18 Other species recorded most years around the Isle of Lewis include near shore records of minke whales *Balaenoptera acutorostrata*, a small number of bottlenose dolphins *Tursiops truncates* around the north of Isle of Lewis and south of South Uist, occasional groups of common dolphins *Delphinus delphis*, and killer whales *Orcinus orca* of which around 10 individuals have been identified. Other species such as *w*hite-sided dolphins *Lagenorhynchus acutus* and humpback whales *Megaptera novaeangliae* have occasionally been recorded around the Outer Hebrides. (Evans, 2000, Reid *et al*. 2003).

2.19 The Monach Islands is one of the largest breeding colonies in the world for grey seals (*Halichoerus grypus*) but there are also important breeding areas on the islands to the south west of Harris and also on North Rona, north of the Butt of Lewis. Grey seals are listed on Annex II of the EC Habitats Directive. About 39% of the world population of grey seals are found in Britain and 90% of these breed in Scotland.

2.20 Harbour seals (*Phoca vitulina*) are listed on Annex II of the EC Habitats Directive and are common on the east coast of the Outer Hebrides with approximately 8% of the UK population found there (Duck, 2000). Local

declines have led to the implementation of a Conservation Area for common seals extending across Western Isles coastal waters under the Marine (Scotland) Act 2010, which restricts the issue of control licenses.

2.21 Basking sharks *Cetorhinus maximus* are regularly recorded around the Isle of Lewis and the rest of the Outer Hebrides. The north western Scottish coast has been identified as a Basking Shark "hotspot" with relatively high numbers observed during the summer months (The Basking Shark Project).

2.22 Basking sharks are listed as Endangered on the IUCN Red List of Threatened Species and has full protection under the Wildlife & Countryside Act 1981 (as amended by the Nature Conservation (Scotland) Act 2004, is protected under appendix I and II of the Bonn Convention and is listed on the 2004 Initial OSPAR list of threat and/or declining species.

2.23 The north-eastern coastal waters off Lewis are included in the Eye Peninsula to the Butt of Lewis Marine Protected Area (MPA) search location. The search location is for four proposed protected features, Risso's dolphin, sandeels *Ammodytes* spp. and geodiversity features associated with the Quaternary of Scotland and Marine Geomorphology of the Scottish Shelf Seabed (Scottish MPA Project 2012).

3. Methods

Aerial survey desk study

3.1 A desk study was undertaken in September 2011 to identify previous seabird survey datasets available from the west coast of Lewis. Historical aerial survey data and reports from WWT Consulting and Joint Nature Conservation Committee (JNCC) were reviewed.

Digital aerial survey strip transect methodology

Survey dates

3.2 Seven surveys between April 2012 and February 2013 were planned in the survey programme, focussing on key ecologically relevant seabird periods through the year:

- One in late April;
- One in May;
- One in June
- One in mid July/mid August;
- One late August/early September;
- One in January; and
- One in February

3.3 Actual dates of surveys accomplished are presented in the Results section below.

Aerial survey design

3.4 To achieve a robust sampling regime from which seabird population estimates could be calculated with relatively high confidence, a series of 32 transects were used running perpendicular to the main coastal depth gradient covering the study area (Figure 1). The area covers the areas of wet renewables development identified in the Regional Locational Guidance and includes a 2km buffer area around these.

3.5 For an optimum combination of coverage and species identification the area was surveyed with a sensor array comprised of four 2cm Ground Sample Distance super high-definition video cameras each with 50m strip width on the ground, giving a total strip width of 200m, and overall 10% coverage of the study area.

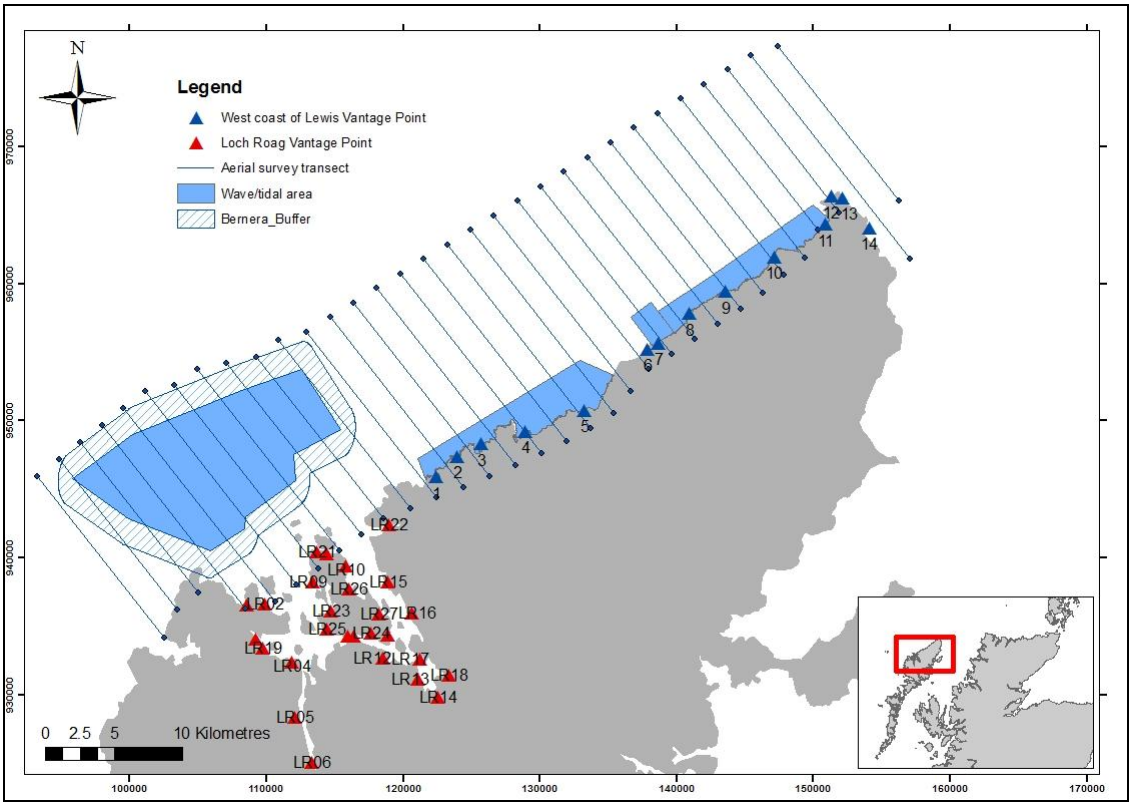
Strip based analysis

3.6 The HiDef approach is based on the continuous capture of super high definition video which offers considerable flexibility for subsequent application of strip analysis. Running in excess of fourteen frames per second the camera array (comprised of four cameras for this project) produced a set of four continuous imagery strips for each transect. The strips were separated by 50m to ensure that there is no duplication of counts as a result of flying birds crossing into the view of one camera from another.

3.7 These video strips form a rich data source for analysis immediately following capture and may subsequently be revisited should areas or species prove to be of particular interest at a later date.

3.8 Surveys were planned to be conducted in conditions of sea states of calm to slight, cloud cover over 2,000 feet and good visibility, using a range of long and short range forecasts for the region and further offshore. All surveys were carried out adhering to WWT Consulting/HiDef's strict health and safety policy.

Figure 1 - Digital aerial survey line transect and vantage point (VP) locations in relation to wave/tidal areas of interest. VP numbers refer to those used in Table 2 and 3



3.9 On completion of surveys, data were backed up and returned to HiDef for processing, storage and analysis. Reviewers at HiDef reviewed 100% of the video footage and identified objects that were potentially birds or marine mammals. The times and frame numbers of these were logged on a spreadsheet subsequently sent with copies of the video data to trained observers at WWT Consulting for identification. Twenty percent of footage reviewed was blind-reviewed a second time as part of HiDef's Quality Assurance process to ensure 90% or better match between reviewers in detecting objects. This Quality Assurance Process is outlined in Figure 2 (Appendix I).

3.10 On receiving the marked spreadsheets and video data, WWT Consulting ornithologists recorded the species (where possible), species group and behaviour of those objects identified by the reviewers. WWT Consulting's identification system allows a confidence category to be assigned to each record at the species and species group level, which can be 'definite' (99+% confident – diagnostic features clear), 'probable' (more than 50% confident – diagnostic features indicated but not clear,) and 'possible' (less than 50% confident – no diagnostic features but *GISS* (general impression of size and shape*)* is indicative). Where identification to species was not possible, for example due to a sitting gull or auk presenting insufficient features for an identification in the given light conditions, 'No ID' was recorded as the species but the lowest taxonomic level identification possible given as the species group. Occasionally, bird behaviour combined with ephemeral light and weather conditions at sea create images which are difficult to identify. In these cases broad species group categories are used for species which would

ordinarily be easy to separate, such as ‘auk/small gull’. Species groupings used in the analysis are detailed in Table 4 (Appendix II).

3.11 Records were then geo-referenced to produce locations of sightings.

3.12 For Quality Assurance purposes, 20% of all object records were selected at random and analysed by a second observer without reference to the original analysis. The data sheets were compared for species and species group identification and confidence levels and the original sheet accepted if there was 90% or better agreement, or a feedback system using a 3rd observer instigated. This process is summarised in Figure 3 (Appendix I).

3.13 For the purposes of calculating abundance estimates for species all levels of confidence of identification were combined. There are arguments for and against this approach, with alternatives including to only use probable or definite identifications. However including all levels (except ‘No ID’) represents the best identifications available by experienced ornithologists and not including them is more likely to result in bias caused by under-estimates for those species. Identifications to different confidence levels are presented in Results below and the data spreadsheets supplied to the client have the confidence levels against each record, so they are available for further scrutiny and different analysis approaches if required at a later stage. Obviously records for ‘No ID’ will lead to some underestimation of species abundances and where these are frequent, it is more appropriate to analyse these records at the species group level, for example for ‘auk species.’

3.14 Note that correction factors have not been applied for diving species to account for a proportion of birds that may have been underwater and thus unavailable for counting. Density estimates for these species referred to in the results should thus be interpreted as minimum uncorrected densities.

Ground-based point count methodology

3.15 To provide ground count data that complement and ‘ground truth’ the aerial survey data, surveys were undertaken from vantage points (VP) located at approximately equal intervals along the NW coast of Lewis (Port Ness southwest to Carloway). The exact locations were chosen on the basis of the view they afforded of the sea, the height above sea level and the desire to include area with breeding seabirds.

3.16 For the Loch Roag survey area, vantage points were positioned around the coasts of Loch Roag as frequently as required to give good coverage of the whole of the survey area but mediated by access considerations. Apart from the outermost parts, Loch Roag was not covered by the aerial survey (Figure 1).

3.17 Survey work was undertaken by an experienced ornithologist working from a series of carefully selected shore vantage points (VP). VPs were selected on the basis of ease of access and the view they afforded. Binoculars (10 x magnification) and a zoom spotting scope (20-60 x magnification) were used to help find and identify species out to a range of 2km (in good conditions).

NW coast – Port Ness via Butt of Lewis southwest to Carloway

3.18 This is a long, very exposed stretch of coast. Access from roads is mostly good but intermittent, and there is mostly adequate elevation for VPs. At the north end, round the Butt of Lewis east to Port Ness, there are cliffs with moderate numbers of breeding seabirds.

3.19 Initially, fourteen VPs were used along this stretch though some of these were later discontinued due to either poor elevation or restricted view (Figure 1). This stretch of coast includes the locations of the two VPs used to collect data for the baseline seabird and marine mammals studies for the proposed Lewis Wave Array (Aquamarine Power Ltd) and these VP locations were also used for this study.

3.20 The counting method involved undertaking a single 'snapshot scan' from each VP on each survey date. The aim was to measure the instantaneous distribution of birds, seals, cetaceans and basking sharks using the area of coverage visible from each VP ; typically (depending on the adjacent coastline geography) comprising a semicircle of sea up 2 km offshore. A snapshot scan took about 30 minutes to complete, depending on how many birds were present. Except for scarce species (e.g. divers, Arctic skuas *Stercorarius parasiticus*), flying birds that were transiting through the area of coverage were not recorded. Searches were undertaken by systematically searching the arc of the search area from one side to other using a combination of telescope and binoculars, going sufficiently slowly so as to reduce the likelihood of overlooking actively diving birds or cetaceans because they are underwater (dives by birds typically last <1 minute).

3.21 For seabirds the species; age/size; group size; behaviour; activity when first seen; location; and travel direction were recorded. In the case of marine mammals and basking sharks the following was recorded: time; species; age/size; group size; activity when first seen; location and travel direction.

3.22 An animal's location was recorded in terms of a compass bearing (measured using compass binoculars) and an angle of declination from the VP. Trigonometry was later used to calculate the grid reference of locations from these field measurements and the height above sea level and grid reference of VPs.

3.23 The angle of declination was measured using a digital level attached to a spotting scope firmly mounted on a tripod fitted with a levelling head. The digital level measured angles to a precision of 0.05 degrees. The angle of declination of the horizon was also measured to provide a consistent reference.

3.24 VP watches were undertaken in sea state conditions of moderate or less and not in continuous heavy rain or when good visibility was less than 2km.

Loch Roag

3.25 Twenty seven VPs were used to cover Loch Roag. Figure 1 shows the location of the VPs, Table 3 (Appendix II) the count location names, grid references and coverage. There was some variation between survey visits in the VPs used;

the choice of VPs depended on light and wind conditions at the time and the amount of day light time available to count.

3.26 As far as possible survey work was restricted to fair weather and relatively calm sea conditions (below sea state 3). Each visit was planned to be completed in a single day, though in practice the July visit was spread over several days due to unsettled weather and the two mid-winter visits were spread over two days due to daylight constraints.

3.27 The surveyor searched all areas of water and shoreline visible from the vantage point, typically spending about 15-25 minutes at each point; the actual time depended on the sea conditions, numbers of animals present and the extent of the visible area, and to some extent how much time was available (see Future Recommendations).

3.28 All target species (seabirds, marine mammals and basking sharks) seen were recorded in terms of species identity, age/size, plumage, behaviour and location. Time, weather and sea conditions were also recorded.

3.29 Inner Loch Roag extends over 103 individual 1km squares, though most of these contain some land. The whole area has complex coastlines with many small islands and skerries (Figure 1). The 1km square as apparent from a 1:50,000 scale OS map (Landranger series Sheet 13) was recorded for all target species. This was considered to give adequate spatial resolution and proved to be a highly satisfactory and easy method for recording location.

3.30 Observers were vigilant to the possibility of double recording, i.e. the possibility that the same individual was recorded from adjacent vantage points. This problem was minimised by appropriate spacing of vantage points and observers only recorded individuals that they believed were different to those previously recorded on the same visit. Because of these measures the potential for double recording to inflate total counts is believed to be negligible.

3.31 The potential for under recording was much greater because on all visits some areas of Loch Roag were not visible from all vantage points or were too distant (>2km) from the vantage point, and so complete coverage was not achieved. Furthermore, it is possible that some actively diving species were overlooked even if they were within the visible areas searched. The problems of under recording were reduced by choosing vantage points that maximised coverage, surveying in low sea states and good light, and searching from each vantage point for as long as time permitted, (but bearing in mind the aim to complete each visit in a single day - (see Future Recommendations).

3.32 Data were entered into an Excel spread sheet and exported to ArcMap GIS to produce maps. Pivot table routines within Excel were used to tabulate results.

3.33 The inner Loch Roag survey area was arbitrarily divided into five survey sectors to facilitate the reporting of results (Figure 4, Appendix I).

3.34 No attempt has been made in this report to account for under recording caused by either overlooking birds in the areas searched or because some parts of the survey area were out of view from all vantage points. Attempt was also not

made to correct density estimates for decreasing detectability of birds further from the observer, due to the confounding and for this study (given small sample sizes) inseparable effects of detectability and the ecological variable distance from coast. However see below for comparison of aerial survey and ground count methods where the relative effect of these has been studied. Thus VP density estimates should be considered as minimum uncorrected densities particular for distances of over 1km from the observer.

Abundance estimates

3.35 Point abundance estimates in the study area for each species recorded from aerial surveys were calculated from design-based analysis of encounter rates within the strip transects following Buckland *et al*. (2001).

3.36 For divers and auks, abundances of each species were estimated using encounter rates of records as above, but also by applying the proportions of species identified in each aerial survey to the total estimates for those groups.

Density surface modelling

3.37 Density surface modelling was applied to the digital aerial survey data only.

3.38 The count model of Hedley and Buckland (2004) was used to model trends in spatial distribution of birds in the study region. In this approach, the realised survey tracklines were divided into small segments each 1km long and the response variable in the statistical model was the estimated number of birds in the segment. In contrast to line transect surveys, during the video surveys birds were recorded in strip transects, so there was no adjustment for detection probabilities.

3.39 The British National Grid (Ordnance Survey) easting (*x*) and northing (*y*) coordinates of the birds were fitted as a smoothed two-dimensional term in a Generalised Additive Model (GAM) with a negative binomial error distribution. To reduce the likelihood of overfitting the maximum number of knots *k* was set to 10 and gamma 1.4 was used to penalise models with higher degrees of freedom (Wood 2006). Automatic smoothness selection through Restricted Maximum Likelihood Estimation (REML) was used in the GAM function of the 'R' package 'dsm' (R Development Core Team 2008, Miller *et al*. 2013). For this project the use of mixed models (GAMMs) to explore autocorrelation in the data was not undertaken.

3.40 The GAM was used to predict density of birds in a 1km x 1km 'prediction grid' populated with the explanatory variables *x* and *y* covering the study region and abundance obtained by integrating under this surface.

3.41 Thus the model used was: N ~ s(x, y, k = 10) + offset, Family = negative binomial, Theta = 0.166, gamma=1.4.

3.42 The variance of the abundance estimates derived through density surface modelling was calculated using the variance estimation via Bayesian results method of Wood (2006) as implemented in package 'dsm'.

Comparison of aerial survey and ground count methods

3.43 Locations of records from aerial and vantage point surveys were overlaid as layers in ArcGIS for comparison where spatial coverage overlapped and temporal coverage overlapped or was similar.

3.44 To compare densities for auks data were split into those Vantage Points (Port of Ness, Butt of Lewis E, Butt of Lewis W and Swainbost) and aerial survey transects (transects 1-4) around the Butt of Lewis and the remainder of the west coast vantage points and their respective aerial survey transects (transects 5-21). Aerial survey transects south of transect 21 (transects 22-32) and thereby more than 2km away from the area covered by Vantage Points were excluded from these analyses. Using ArcGIS arcs were drawn around each Vantage Point representing the area surveyed. These were intersected by 500m distance bands from each VP to derive areas and thence densities in each band. The resulting intersected polygons were subsequently intersected by 500m distance bands from the coast so that densities in these bands could also be calculated. Data beyond 2km and any birds on land or flying were removed from analyses. The aerial survey transects were intersected by 500m distance bands from the coast and densities derived for records of sitting birds of each species or species group within these. Densities were combined from each sub-set of samples (around Butt of Lewis or west coast of Lewis) and by season: April to July or September to February.

4. Results

Desk study

4.1 The only published surveys of seabirds to have taken place to the west of Lewis are reported in Webb *et al.* 1990. These surveys consisted of boat-based surveys from chartered boats and ships of opportunity, visual aerial surveys at 4 and 9 km from the shore and a series of winter point counts in Loch Roag during the winter. Surveys mainly took place between 1986 and 1989. These showed the area to be of importance for divers (mainly in the winter, especially in Loch Roag); fulmars, European storm-petrels (around the Butt of Lewis in summer); gannets (mainly around the Butt of Lewis in summer); cormorants and shags (especially in Loch Roag); eiders *Somateria mollissima* and red-breasted mergansers *Mergus serrator* (especially in Loch Roag); lesser black-backed gulls, herring gulls and great black-backed gulls (mostly in offshore areas and around the Butt of Lewis); kittiwake (mostly around the Butt of Lewis); guillemots, razorbills and puffins (mainly around the Butt of Lewis, but concentrations of puffins around Gallan Head ca. 20km south-west of Loch Roag); and black guillemots (Loch Roag and adjacent open coastline and around the Butt of Lewis). They identified the area around the Butt of Lewis to be of particular importance for moulting auks and other seabirds during the late summer and early autumn.

4.2 WWT Consulting undertook a visual aerial survey covering an area around North and South Uist on 30th July 2007. During the survey a wide range of seabird species were seen including; Arctic skuas, great skuas *Stercorarius skua*, black guillemots, fulmars, gannets, Manx shearwaters *Puffinus puffinus*,

kittiwakes and auk species. The majority of birds were seen in small numbers (less than 50) with only gannets recorded in large numbers (950).

4.3 Annual aerial surveys have been carried out by JNCC between March 2003 and March 2007 focusing on the inshore areas on the west coast of the Outer Hebrides, including the west coast of Harris, North Uist, Benbecula, South Uist and Barra and thus south of the study area. These surveys were targeted at seaducks and divers and have revealed regular wintering populations of great northern divers, eiders, common scoters *Melanitta nigra*, red-breasted mergansers and long-tailed ducks *Clangula hyemalis* (JNCC 2010b).

Digital aerial survey results

Survey dates

4.4 Table 1 shows the dates of digital video aerial surveys and their associated survey conditions. The May 2012 and February 2013 surveys were due to take place on the 2nd of those months, however a technical fault with the aircraft on both dates prevented this so they were postponed to the next suitable weather opportunities on 29th May and 12th February respectively. The ground counters were already in place or had started counts on both occasions so these were completed in the absence of synchronised aerial surveys.

Table 1 - Survey dates, times and conditions

Date of survey	Start time	Time on survey	Wind Beaufort scale	Cloud	Sea state
19th April 2012	11:50	3hr 3min	Force 3-4 easterly	Scattered	3-4
29th May 2012	14:46	2hr 59min	Force 5 north easterly	No cloud	3
18th June 2012	11:21	2hr 45min	Force 1 northerly	Scattered	1
26th July 2012	10:41	2hr 39min	Force 2 westerly	Overcast	2
22nd September 2012	11:39	2hr 43min	Force 3 Westerly	Overcast	2 - 3
17th December 2012	12:04	2hr 35min	Force 3 South Easterly	Overcast	2- 3
12th February 2013	12:10	3hr 2min	Force 3 Easterly	Scattered	5

Transect Counts

4.5 Counts of each species recorded in the survey strips during each survey are presented in Tables 5 and 6 (Appendix II).

4.6 Locations of records are provided in Figures 5 to 47 (Appendix I). This also shows information on behaviour and flight direction.

April

4.7 In April, a total of 803 birds were recorded. Fulmars were the most numerous species, with a count of 318 birds. A further 80 records, mainly of sitting birds, were identified to the species group fulmar/gull species, and 46 birds were recorded as fulmar/small gull (excluding little gull). Fulmars were recorded throughout the survey area with a larger concentration in the south west. This included approximately 160 individuals that were recorded within the Bernera Wave Farm development area and its 2km buffer (BWF).

4.8 Large auks (guillemots or razorbills) were the next most abundant species, with 88 recorded. Sixty five birds were recorded as auk species (guillemots, razorbills, black guillemots, puffins or little auks), 35 as guillemots, 10 as puffins and six as razorbills. Seven birds were identified as small auk (little auk/puffin) and fifteen birds were assigned the category of auk/small gull (auk species, black-headed gulls, little gulls, common gulls or kittiwakes).

4.9 Auks were recorded throughout the survey area with between 20 and 30 individuals recorded within the BWF. This included guillemots and razorbills with the other individuals not identified to species. The distribution showed greater auk numbers at the north end of the island consistent with the findings of Webb *et al. (*1990) from March to June.

4.10 There were 44 records of gannets and 30 records of kittiwakes during the April flight with approximately a third of these records occurring within the BWF.

4.11 One great northern diver was identified, along with six unidentified diver species. One Iceland gull was recorded with two herring gulls and one lesser black-backed gull. One black-backed gull species (lesser or great black-backed gull) was recorded with one small gull species and two small gulls (excluding little gull) and three gull species.

4.12 There was also a count of four great skuas, two greylag geese *Anser anser*, two eiders, one small wader species and three unidentified storm petrels. Seventeen birds were given the category ‘small bird’.

4.13 Cetaceans and seals were recorded during the April survey; the highest count was of six harbour porpoises. Four white-beaked dolphins were recorded, as was one seal species. Half of the harbour porpoise records along with all of the white-beaked dolphin records occurred in the BWF.

May

4.14 In May the total number of birds counted was lower, with 347 records. Gannets were the most numerous bird recorded. Their numbers had increased to a count of 91, over twice the April numbers. Fulmar numbers had decreased by over 200 individuals since the April flight to a count of 84, in addition to five fulmar/gull species. This decrease may reflect increased nest attendance or a stochastic event in distribution. Fulmars should have returned from their pre egg laying exodus by the time of survey as apparently occupied sites (AOS) and eggs had been recorded at other colonies by third week of May (e.g. Aiton *et al*. 2012). 26 gannets were recorded within the BWF with individuals flying

and sitting. Fulmar numbers in the BWF were small with 5 individuals recorded flying through the area. High numbers of fulmars were recorded in the wave areas of interest close into shore. These are likely to be breeding birds located around nest sites on the cliffs.

4.15 Forty auk species were recorded, with 12 large auks, one small auk, 22 puffins and one guillemot. One puffin was recorded within the BWF with three other records of auk species. The fewer auks recorded may reflect peak colony attendance during May.

4.16 Eider numbers increased in May with 25 records along with two unidentified duck species.

4.17 Sixteen common gulls and one great black-backed gull were recorded in May, these species were absent from the previous month's survey. Three herring gulls were counted with two kittiwakes, one gull species and one small gull species. Three common gulls were recorded flying through the wave areas of interest with one herring gull recorded loafing on the land on the edge of the development area.

4.18 Three Arctic/common terns were recorded in May, with 15 unidentified tern species plus one tern/small gull species.

4.19 Ten greylag geese were recorded as well as one shag, two cormorants, five wader species and three small birds.

4.20 No cetaceans or seals were recorded in May.

June

4.21 In June total bird numbers recorded had increased from May, with a total count of 516 individuals.

4.22 Fulmars were again the most numerous bird with 105 being counted along with 25 fulmar/gull species, one gull species, three small gull species and one fulmar/small gull (excluding little gull). Compared to the previous month few individuals were recorded in the coastal wave areas of interest. Approximately 10 individuals were recorded within the BWF.

4.23 Eighty one large auks were recorded, with 78 auk species, 32 puffins, three guillemots and two small auks. One shearwater/auk species was also noted. Five puffins and one guillemot were recorded in the BWF with small numbers of unidentified auk species recorded here and also in the coastal wave area of interest.

4.24 Fewer gannets were recorded in June than May, with a count of 69, 19 of which occurred in the BWF. Twelve eiders were counted in June with two common scoters and three unidentified duck species.

4.25 Kittiwake numbers had increased since May, with a count of nine. Seven herring gulls were recorded along with four black-headed gulls, which were recorded for the first time this month. Two common gulls, one great black-

backed gull, one grey gull species (herring gull or common gull), one lesser black-backed gull and one gull species were also recorded.

4.26 Thirteen unidentified tern species were recorded, three Arctic/common terns and one tern/small gull species.

4.27 Two red-throated divers were recorded in June along with one unidentified diver species and two large auk/throated divers.

4.28 Four unidentified wader species and an oystercatcher *Haematopus ostralegus* were recorded. Of those bird objects that could not be identified to family, six 'small birds' and one 'big bird' were recorded.

4.29 Cetaceans, seals and sharks were all recorded in June with 15 harbour porpoises, one minke whale, five unidentified seals, two grey seals, one small cetacean/seal species and one basking shark identified. Four of the harbour porpoises, the minke whale, basking shark and one of the grey seals were all recorded swimming through the BWF. Only one record was made close to shore with a harbour porpoise recorded on the edge of the wave area of interest.

July

4.30 In July total bird numbers increased again, with 541 individuals being recorded.

4.31 Gannet numbers in July were almost three times the June count, with 199 individuals counted. 61 were recorded within the BWF with a number of sitting birds observed in the centre of the development area.

4.32 Fulmar numbers had increased slightly from June's count with 114 identified plus six fulmar/gull species. 16 were recorded within the BWF.

4.33 Large auk numbers dropped slightly from June with a count of 63, auk species numbers dropped by more than half from the previous month with a count of 30, however more auks were identified to species, with two black guillemots and 13 guillemots recorded. Fifteen puffins and four razorbills were identified. Three small auks were also noted. Single puffin, razorbill and guillemot records were made within the BWF with another single puffin record from the inshore wave areas of interest. Small numbers of unidentified auks were recorded in all three wave areas.

4.34 Greylag geese records had increased in July with a count of 16.

4.35 Eight kittiwakes were recorded, along with three lesser black-backed gulls, two herring gulls, one great black-backed gull, one common gull, one large gull species and one unidentified gull species.

4.36 Two Arctic/common terns were recorded and three unidentified tern species, a red-throated diver, a shag, a great skua and one unidentified skua species.

4.37 Fifteen unidentified storm petrels were counted in July, along with one unidentified duck species, one small wader species, one shearwater species and fourteen small birds.

4.38 Cetaceans, sharks and other marine mammals were more abundant this month, with four Risso's dolphins, three white-beaked dolphins, two common dolphins a basking shark, a grey seal and two unidentified seal species recorded.

September

4.39 September saw an increase in bird numbers from July with 639 individuals recorded.

4.40 Gannets were the most numerous species with 247 individuals recorded, 48 of which occurred within the BWF. Very small numbers were also recorded in the coastal wave areas of interest.

4.41 Greylag geese were at their highest number with 116 individuals recorded. All of these records were recorded over land however.

4.42 Fulmar numbers dropped significantly with only 28 individuals recorded. Approximately two thirds of these records occurred within the BWF with no records occurring in the coastal areas of interest. Greater numbers were displayed in the south west of the survey area in contrast to Webb *et al*. (1990) which showed fewer numbers for September to November when compared to other areas.

4.43 Only small numbers of auks were identified to species in September with 11 guillemots, three razorbills and one puffin recorded. A further 52 auks were recorded with 28 identified as large auks and 24 recorded as unidentified auk species. A single guillemot and small numbers of large and unidentified auks were recorded in the BWF with single records of guillemot and large auk species recorded in the coastal wave areas of interest.

4.44 Gulls occurred in small numbers with four kittiwakes, three common gulls, two lesser black-backed gulls and a single great black-backed gull identified. The only gulls recorded within the BWF were two large gulls that were not identified to species.

4.45 Diver and cormorant records were all confined to the areas adjacent to the shore with three red-throated divers and individual shag and cormorant records. Only one red-throated diver was recorded within the more northerly coastal wave area of interest.

4.46 Basking sharks reached their maximum count during September with six individuals recorded. Marine mammals occurred in smaller numbers with a single harbour porpoise a common seal and two grey seals recorded.

December

4.47 Fulmar numbers increased dramatically during December with 133 individuals recorded. These were largely concentrated in the southwest of the survey area with 37 occurring within the BWF. This south westerly distribution of fulmar is absent from the findings of Webb *et al*. (1990) but both sets appear to show a higher distribution around the northern tip of Lewis. Fewer individuals were

seen close into the coast with only one recorded within the coastal development areas.

4.48 A total of 92 auks were recorded with two puffins and two guillemots recorded. 82 individuals were recorded as unidentified auk species with a further six identified as large auks. Both guillemot records and one of the puffin records were made within the BWF along with approximately 20 individuals that could not be identified to species.

4.49 Gull numbers increased from the previous month with 22 kittiwakes, six herring gulls, nine lesser black-backed gulls and two great black-backed gulls recorded. Unidentified gull numbers also increased with 27 unidentified gull species and 17 large gulls recorded. Five of the kittiwake records along with five unidentified gulls were recorded within the BWF. Very small numbers were recorded in the coastal areas with the majority of the records occurring either over land or directly adjacent to the coast.

4.50 Divers occurred in their highest numbers with one red-throated diver recorded and 26 unidentified diver species recorded. The unidentified divers occurred in three groups all of which occurred in the coastal wave areas of interest.

4.51 Gannets occurred in their lowest numbers with only two individuals recorded. Cetacean numbers were also greatly reduced with a single harbour porpoise recorded in the southwest of the survey area.

February

4.52 Fulmar numbers continued to increase with 186 recorded during February. As with the December survey, large numbers occurred in the southwest of the block with 122 individuals recorded within the BWF.

4.53 Auk numbers remained high with a total of 177 individuals recorded. This included five puffins, one guillemot, two small auks, 13 large auks and 156 unidentified individuals. Approximately 30 records occurred within the BWF and included the guillemot record and two of the puffin records.

4.54 Gull numbers continued to increase with 121 kittiwakes, 14 herring gulls, 11 great black-backed gulls and single lesser black-backed gull and black-headed gull records made. Three of the great black-backed gulls were recorded within the BWF along with approximately 30 kittiwake records.

4.55 Diver numbers reduced during February with only three unidentified divers recorded. 13 eiders were recorded around the mouth of Loch Roag and two common scoters were identified in the north of the survey area. These and two of the diver records were made within the northern most wave area of interest.

4.56 Gannet and marine mammal numbers remained low with only five gannets recorded and again a single harbour porpoise record.

Abundance estimates

4.57 Table 6 (Appendix II), presents point abundance estimates for each species in the study area from design-based analysis of encounter rates within the strip transects following Buckland *et al*. (2001).

4.58 The abundances estimated for all species and species groups are approximately ten times the number of records recorded, as the strip transect survey covered 10% of the study area.

4.59 For those species, where only a single record was made, this was simply multiplied by 10 to obtain an estimate. Compared with breeding population counts from seabird colonies within foraging range (from the Seabird Monitoring Programme (http://jncc.defra.gov.uk/smp/) the estimated abundances of species recorded were low. This may be attributed to low relative importance of the area for these seabird species, particularly for those from more distant colonies having larger foraging ranges where the study area occupies a much smaller proportion of foraging area available. However it may also incorporate stochastic or sampling methodological issues such as colony attendance, chance foraging out of the area and availability of diving birds, which is discussed below (Comparison of ground-based and digital aerial survey).

4.60 A maximum of 3,161 fulmars were estimated to be in the study area (Table 6) which was just 3% of the fulmars breeding within the colonies within foraging range on the Flannan Islands, St Kilda, the Monach Isles, North Rona, Sula Sgeir, the Shiant Isles, Handa and Cape Wrath.

4.61 Gannet abundance estimates peaked at 2,464 in September (Table 6), which again is around 1.7% of the 146,574 gannets breeding on the colonies at Flannan Isles, St Kilda and North Rona & Sula Sgeir.

4.62 Around 254,000 auks were counted on colonies within foraging range of the study area during Seabird 2000, of which the peak count of 2,051 auks in April was less than one percent.

4.63 In December 269 divers were estimated in the study area. If more than 170 of these were red-throated divers this would represent over 1% of the British wintering population (Musgrove *et al*. 2011). The ground counts in December recorded higher numbers of great northern divers than red-throated divers (see ground-based count results below) in which case if more than 25 were great-northern divers, this would exceed the overwintering 1% threshold for this species. In April 69 divers were estimated, which based on observed species ratios could have been great northern divers, so again this would exceed the overwintering 1% level. The estimates of unidentified diver species in June July, December and February exceed the overwintering 1% level for great northern diver and black throated diver (1% = 6) though obviously the actual numbers of these species present are unknown.

Ground-based count results for northwest coast of Lewis

4.64 Table 2 presents the dates that ground counts were undertaken. Ground counts were conducted on the same days as aerial surveys on 19th April, 18th

June, 26th July, 22nd September and 17th December 2012. In May the ground count was undertaken on 2nd May, when the original aerial survey was planned, but the aerial survey was postponed until 29th May due to a technical fault. Similarly in February 2013 the ground count was started on 2nd February, when the aerial count was due to take place but on transit the survey aircraft had to abort due to a technical fault and did not complete the survey until 12th February.

4.65 Numbers of birds recorded from each vantage point on each date are shown in Table 7 (Appendix II). Numbers of marine mammals and basking sharks are presented in Table 8 (Appendix II).

4.66 Locations of records are presented in Figures 48 to 84 (Appendix I).

April

4.67 In April, fulmars were the most commonly recorded bird with 25 counted, nine of which were at Port of Ness. Common gulls were the second most abundant bird, with 15 recorded. Eleven great northern divers were seen, 10 shags, nine herring gulls, eight black-headed gulls and eight guillemots were also recorded.

4.68 There were six records each of black guillemots, razorbills and lesser black-backed gulls. Four great black-backed gulls and four large auks (guillemots or razorbills) were also seen. Three gannets were recorded. There were single records for red-throated diver, great skua, Iceland gull *Larus glaucoides*, unidentified gull species and a cormorant. A total of 122 birds of 19 species were recorded in April.

4.69 In April sea state ranged between 3 and 5 during the VP counts so it is possible some, especially cetacean species were not detected.

May

4.70 In May, fulmar numbers had increased with a count of 37; again the highest number was at the Port of Ness (15). Great northern diver numbers had also increased with 20 being recorded. Razorbills and guillemots had also become more numerous with a count of 17 and 14 respectively. Shag numbers had a small increase since the previous month with 13 recorded.

4.71 Nine black guillemots were seen, and nine puffins were also counted, this species was not recorded at all in April. Five red-breasted mergansers were seen, all from Bragar. Five gannets were also counted. There were two records each of red-throated divers, kittiwakes, black-headed gulls, great black-backed gulls and cormorants. Large auk species, lesser black-backed gull and Slavonian grebe *Podiceps auritus* had single records each. A total of 145 birds of 18 species were recorded in May.

June

4.72 In June, bird activity had generally increased with 245 birds of 21 species being recorded. Guillemots were the most abundant with a count of 85, the majority being recorded from Port of Ness and Butt of Lewis East. Fulmar numbers had

increased again with a count of 52. Twenty six black guillemots were recorded, the highest count (11) coming from the Butt of Lewis West.

4.73 Gannets were recorded around the coast, with a count of 19. Thirteen shags were recorded in June, as were eight Arctic terns *Sterna paradisaea*. Six large auk species and six razorbills were seen. Common gulls were recorded again in June, with a count of four. There were three records each of red-throated divers, great northern divers, and herring gulls and two records of Arctic skuas, great black-backed gulls and puffins. There were single records of black-headed gulls, black-throated divers, cormorants, common terns, lesser black-backed gulls and great skua.

4.74 One unidentified dolphin species, two grey seals and four harbour porpoises were recorded from vantage points in June.

July

4.75 In July, bird activity had generally decreased with 111 birds of 18 species being recorded. The most abundant species in July was shag with 37 records. There were 22 records of black guillemots, 12 records of guillemots and six records of fulmars. Razorbills, great northern divers and gannets had five records each. There were counts of four individuals for red-throated divers and Arctic terns, and three gannets were recorded. There were single records for Arctic skua, cormorants, great black-backed gulls, large auk species, kittiwakes, great skuas and European storm-petrels.

4.76 In the July counts a basking shark, five grey seals and a harbour porpoise were recorded.

September

4.77 A total of 315 birds were recorded during the September count with 10 different species recorded. The most abundant species were gannets with 161 individuals recorded. All of these records were made from the count points in the north west with a number of individuals occurring within or just outside of coastal wave areas of interest.

4.78 Shags were the next most abundant species with 99 individuals recorded with most records occurring around the Butt of Lewis.

4.79 All of the other species recorded occurred in much lower numbers with 17 herring gulls, 13 great back-backed gulls, nine common gulls, six cormorants, four guillemots, three razorbills, two red-throated divers and a single black guillemot record.

4.80 A single basking shark record was also made along with eight grey seals. No cetaceans were recorded during this survey.

December

4.81 Total bird number decreased during the December survey with 247 individuals recorded. Eleven different species were recorded with fulmars the most

abundant species. 83 individuals were recorded with all of the records occurring in the northwest of the survey block around the Butt of Lewis.

4.82 Eiders were the second most abundant species with 62 individuals recorded from the Melbost vantage points. These were recorded in two separate groups close in to the shore.

4.83 Gulls were recorded in slightly higher numbers with 33 herring gulls, 18 great black-backed gulls and four common gulls and kittiwakes seen.

4.84 Ten great northern divers, three red-throated divers and 26 shags were recorded within inshore waters with very low numbers of auks recorded in the northwest of the survey area. This included a single guillemot record and three black guillemot records.

4.85 No cetacean, mammal or shark records were made during December.

February

4.86 Numbers of birds more than doubled between the December and February counts with a total of 655 individuals recorded, comprising 12 species. This included a large count of 430 fulmars with all but one individual seen around the Butt of Lewis. Herring gull numbers continued to increase with 103 birds recorded. Other gulls seen during this survey included 11 kittiwakes and ten great black-backed gulls.

4.87 Shags were recorded throughout the survey area with 45 individuals recorded. Forty-five guillemots were also seen, all from the Port of Ness vantage point.

4.88 All other species occurred in very low numbers with five great northern divers, two razorbills and single records of red-throated divers, gannets, eiders and black guillemots. In February sea state ranged between 3 and 5 during the VP counts so it is possible some, especially cetacean species were not detected.

Ground-based counts of Loch Roag

4.89 The timetable of planned survey visits proved not possible to achieve due to weather constraints. A total of six survey visits were achieved, in April, June, July and October 2012 and January and February 2013 (Table 9, Appendix II). High quality survey data can only be obtained in calm conditions with good visibility but the summer and autumn of 2012 was notable for long periods of unsettled weather. As a result it proved not possible to undertake a survey visit in May. The planned late August/early September visit also proved impossible to achieve due to weather constraints but was eventually completed on 2nd October.

4.90 The April, June and October visits were all completed in a single day in excellent (April and June) or very good (October) survey conditions and achieved good coverage of the whole survey area (Figure 85, Appendix I). The July visit had to be abandoned twice due to deteriorating weather conditions. Despite attempting July survey work on three dates, weather problems resulted in there being no coverage of the north-west part of the survey area in July (Figure 86, Appendix I).

4.91 The January and February 2013 surveys were achieved in generally excellent survey conditions and good coverage (Figure 87, Appendix I) though spread over two consecutive days each time due to insufficient day length.

4.92 Time constraints meant that it was not possible to achieve complete coverage of the survey area as Figures 85, 86 and 87 (Appendix I) show. The large number of small islands and the indented nature of the coastline meant that even if a 1km square had some visual coverage it was common for a proportion to be out of sight. However, despite these limitations, and with the exception of the north-western parts of the survey area in July referred to above, a very high level of coverage was achieved and it is considered likely that at least 75% of birds on the water in the survey area were recorded on each visit. The corresponding figure for flying birds is likely to be even greater, and is considered likely to exceed 90% detection of birds flying in the survey area. The coverage and detection of hauled out seal in Loch Roag is also considered likely to be at least 75%, however the detection of seals is dependent on hauling-out behaviour which is typically entrained to the tidal cycle. Put simply, seals are most likely to be hauled out within two to three hours either side of low tide and so counts made within this period were more likely to encounter hauled out seals.

Waterbirds

4.93 Thirty eight waterbird species were recorded during the six survey visits (Tables 10 to 12, Appendix II) and both species of seal (Table 13, Appendix II). Details of the numbers seen on each visit in each survey sector are presented for most of these species individually in Tables 14 to 44 (Appendix II).

4.94 On the basis of these results, inner Loch Roag appears to have a relatively high value for six bird species of high conservation importance, namely the three diver species, Slavonian grebes, Arctic terns and common terns. These six species are all on Annex 1 of the EU Birds Directive. Cormorants, eiders and black guillemots, although of lower conservation value, occur in regionally important (>1%) numbers and are therefore also of importance. These nine species are considered to be the priority bird species and each of these is discussed in more detail in the Discussion. Figures 88 to 94 (Appendix I) show the recorded numbers and distributions for red-throated divers, black-throated divers, great northern divers, Slavonian grebe, cormorants, shags and black guillemots.

4.95 The commonest bird species recorded were eiders, shags, herring gulls, great northern divers, black guillemots and greylag geese with over 30 individuals recorded on average for each over the six visits (Table 11, Appendix II). Herring gulls, greylag geese and shags are all common breeding species in Lewis and the numbers using inner Loch Roag are of low importance and with respect to the regional populations. Greylag Geese were particularly abundant in July, and at this time of year a high proportion of the adults seen were accompanied by dependent goslings. A total of 78 goslings in an estimated 18 broods were counted in July. Great northern divers were recorded in greatest numbers in the winter and are regularly occurring winter visitors. The Scottish wintering population is estimated at 1,000-3,000 (Forrester *et al*. 2007) and the biogeographic wintering population 5,000 (Wetlands International 2012) so the

80 and 95 recorded in January and February 2013 respectively represent nationally and internationally important numbers.

4.96 Fulmars, red-breasted mergansers, common gulls, great black-backed gulls, razorbills and gannets were all regularly recorded in more moderate numbers. These are all common species in the Western Isles and it appears that the numbers using inner Loch Roag are of low importance with respect to the regional populations. Five of the 11 razorbills seen in July were accompanied by dependent young. Smaller numbers of black-headed gulls, kittiwakes, little grebes *Tachybaptus ruficollis*, Manx shearwaters, lesser black-backed gulls and a glaucous gull *Larus hyperboreus* were recorded. With the exception of glaucous gull (a regular migrant species) the other species were recorded in very low numbers in respect to regional populations.

4.97 Small numbers of mallards *Anas platyrhynchos* and teals *Anas crecca*, and one pair of shelducks *Tadorna tadorna* were seen on most visits; all these were likely to be breeding locally. These are all common breeding species in the Western Isles. Five common scoters were seen in April; given the time of year and lack of local breeding records, these were likely to be passage birds. The single common scoter seen in June, the height of the breeding season was unexpected and was probably a non-breeding bird, though raises the possibility that this species may breed locally. Small numbers of long-tailed ducks (up to three) and goldeneyes (five) were seen in January and/or February 2013, again representing small relative proportions of these wintering ducks.

4.98 Recording wader species was not an aim of these surveys. Nevertheless it is relevant to report that no significant concentrations of waders were located, nor were significant areas of suitable habitats noted that are likely to be attractive to large numbers of waders. Small numbers (<10 of any species) of oystercatchers, curlews *Numenius arquata*, ringed plovers *Charadrius hiaticula*, common sandpipers *Actitis hypoleucos*, lapwings *Vanellus vanellus* and greenshanks *Tringa nebularia* were seen on the July visit, and all these birds are likely to have been locally breeding birds. The only notable record was five greenshanks seen feeding on intertidal habitat in Loch Cean Hulavig, in the extreme south east part of Loch Roag.

Marine mammals

4.99 No cetacean species (or basking sharks) were seen during the course of the survey work of Loch Roag

4.100 Small numbers of harbour seals (maximum total 12 individuals) were recorded on all visits (Table 45, Appendix II and Figure 95, Appendix I). The great majority of records were from the sheltered south east part of the survey area in Loch Hulavig. The most important haul-out site was at Eilean an Tighe (NB220/300), a small island in the southern part of Loch Hulavig, where up to nine common seals were seen hauled out together. Counting was undertaken irrespective of the tidal conditions. However, counting of the southern parts of the survey area on April and July visits coincided with the low tide period (when seals are more likely to be hauled out) and this may explain why higher numbers were recorded on these survey visits.

4.101 Grey seals were scarce for all surveys except the February 2013 survey when 83 were recorded in the West Great Bernera count section (Table 46, Appendix II, Figure 95, Appendix I).

Density surface modelling of digital aerial survey data

4.102 Sufficient data were collected to undertake density surface modelling for fulmars, gannets and all auk species combined for each month. Table 47 (Appendix II) presents the density surface model statistics and abundance and density estimates obtained.

4.103 Comparison between Tables 6 and 47 shows the abundances estimated from DSM were similar to estimates from the design-based analyses which is to some degree to be expected given the extent and intensity of survey coverage and the inclusion of only *x* and *y* as covariates.

4.104 The resulting density surface maps are shown in Figures 96 to 137 (Appendix I). Accompanying each map is a plot of relative coefficient of variation (CV) – a measure of confidence in the density estimate for each grid cell estimated via Bayesian results as per Wood (2006). Note that legend scales vary between species maps.

Fulmars

4.105 Table 32 shows estimated fulmar numbers decreased considerably in the survey area from 3,197 birds in April to around 1,000 through May (1,159), June (976) and July (1,121) before decreasing to just 302 in September and back up again to 1,295 in December and 1,690 in February 2013.

4.106 The model diagnostics (Table 47, Appendix II), density surface and CV maps for fulmars in April showed a reasonable fit with the observations, though with a relatively high multimodal smooth (estimated degrees of freedom 7.4). Highest densities of up to 18 birds km^{-2} were predicted in the south west of the survey area and around the Butt of Lewis and lowest densities in central areas (Figures 96 & 97, Appendix I). In May, June and July highest estimated densities were close to shore, particularly around Loch Roag and the Butt of Lewis, but with generally lower densities than recorded in April. Note that the high estimated densities east of the Butt of Lewis may be an artefact of this area being the extreme east of the study area and the data showing a correlation with increasing longitude east. This is shown by high CVs in the corresponding CV maps as the modelled estimates here differ from actual densities recorded.

4.107 Few fulmars were recorded in September and the predicted surface reflects the higher densities recorded further offshore than during May to July, particularly in the south west. More ‘flexible’ multimodal models were fitted to the December and February (2013) data with higher overall densities predicted, especially in the south west and north east of the survey area in both months.

Gannets

4.108 The estimated number of gannets in April was 415, increasing to 932 in May, decreasing again to 684 in June before increasing greatly to an estimated 2,035 in July and 2,571 in September. Estimated numbers then decreased again through 887 in December to 50 in February 2013.

4.109 Of the few gannets recorded in April the density surface model reflected slightly higher densities recorded in the south west and north of the survey area. In May, observations were relatively evenly distributed across the survey area, approaching a seemingly more random distribution, so only a weakly fitting model could be fitted (probability *p* that the model had no effect >0.5), with predicted densities around 0.9 birds km^{-2} across the study area, just marginally higher in the north and the south and lower in central areas.

4.110 In June there was a general arc of observations from south of Loch Roag extending to more offshore areas in the centre of the survey area then a broad band of lower concentrations towards the shore in the north. This lead to a relatively flexible model fit (estimated degrees of freedom 7.0) being selected with highest densities up to 3 birds km^{-2} in the south and central northern areas. In July the high recorded numbers were well distributed through the survey area, with a slight trend of higher densities (up to 3 birds km^{-2}) in the south west smoothing to lower densities in the north east.

4.111 In September gannets were even more widely distributed such that the *x*, *y* model with very low estimated degrees of freedom (<1) only accounted for 0.8% of the deviance. The predicted densities were in the range 2-3 birds km^{-2} throughout the study area, with a non significant trend (p>0.1) of slightly higher densities to the north.

4.112 Only two gannets were recorded in December and five in February (2013) so the density surface modelling maps are only provided for completeness and provide some reference for comparing confidence with the other maps.

Auks

4.113 The highest numbers of auks were recorded and estimated in April (2,077), then fewer in May (760) more in June (1,813) and July (1,348) before dropping to the lowest numbers in September (676) before increasing through the winter with 887 predicted for December and 1,765 in February (2013).

4.114 In April the highest auk densities of up to 7 birds km^{-2} occurred around the north end of Lewis with lower densities in the centre of the study area and higher again in the south. This pattern of distribution was similar in May though with lower numbers and estimated densities only up to 3 birds km^{-2} in northern waters and to the south. In June a more flexible model was fitted (estimated degrees of freedom 5.3) predicting highest densities around Loch Roag (up to 6 birds km^{-2}), decreasing through the central part of the study area and increasing again towards the north.

4.115 In July auks were more widely distributed such that the model fit was not significant and accounted for less than 1% of the deviance. Auks were

predicted at densities around 1.3 birds km^{-2} across the study area. In September the highest densities of around 1 bird km^{-2} were predicted radiating out from the observations around Loch Roag but again densities were fairly evenly predicted across the study area reflecting the otherwise wide distribution of the observations and relatively poor model fit (just failing significance at the 5% level).

In December and February (2013) auk observations and predicted densities displayed a similar pattern of distribution to April and May 2012, with significant model fits predicting higher densities in the north and south of the study area (up to 2.2 birds km^{-2} in December and 4.2 birds km^{-2} in February).

Comparison of ground-based and digital aerial survey

4.116 Figures 138 to 142 (Appendix I) show the aerial survey and ground count records made during the synchronised surveys. Only sitting birds are shown as flying birds were generally not recorded during the ground counts.

4.117 From these figures it can be seen that very few records were made in areas of overlapping coverage and no records were exactly coincident in space or time, so using one method to check identification of records from the other is impossible. However a number of general observations were made.

4.118 The ground counts recorded larger numbers of diver species (red-throated divers, black-throated divers and great northern divers), shags and black guillemots overall and given the differences in areas covered higher densities of all auk species.

4.119 Figures 143 to 151 (Appendix I) show the results of detailed analyses of the densities of auk species. These plots attempt to identify patterns in the distribution of auks ('depth' axis) counted from the vantage points and to what extent that pattern may be effected by declining detectability from the vantage point (horizontal axis). The auk densities from aerial surveys in the respective area and season are provided in blue to the right for comparison along the distance to coast gradient. Figure 143 shows that in the breeding season guillemots were recorded at a density of 7 birds km^{-2} within 0.5km of the VPs (and coast) around the Butt of Lewis. Very few guillemots were recorded in the corresponding aerial survey transect segments with a peak density of 0.28 birds km^{-2} occurring 1.5km from the coast, however this is based on few records. More records were made of large auk sp. (guillemot or razorbill) or unidentified auk species. A density of 1.5 birds km^{-2} was estimated for large auk sp. within 0.5km of the coast, with no other auk records. If all of these were actually guillemots, this represents 21% of the density estimated within 0.5km of the VPs. VP records decreased rapidly with both distance from vantage point and distance from coast so as few guillemot records were made from the aerial surveys conclusions cannot be drawn as to the relative affects of decreasing detectability and increasing distance from coast for this species.

4.120 Figure 144 shows the estimated densities for razorbills again in the breeding season months around the Butt of Lewis. These show lower densities recorded from the VPs than guillemots, with a very obvious near shore distribution. Peak density was 1.3 birds km^{-2} up to 0.5km from the VPs and this did not decline

greatly up to 1km from the VP along the coast (up to 0.5km out), however densities beyond 0.5km from the coast were very low. This suggests detectability of razorbills was good out to at least 1km. Given the similarities in structure and plumage between razorbills and guillemots this would also suggest that detectability of guillemots should also have been good out to 1km and so that species too had a predominantly near shore (within 0.5km) distribution in this area. No razorbills were recorded in the corresponding aerial survey transect segments so no direct comparisons could be made. However, summing peak guillemot and razorbill densities within 0.5km of VPs gives an overall density of guillemots and razorbills of 8.3 birds km^{-2} compared to 1.5 birds km^{-2} large auk sp. (guillemots or razorbills) estimated from aerial surveys in this coastal distance band (no other auks were recorded in this band during these months). Thus the aerial survey estimated guillemot or razorbill density was only 18% of that recorded from the VPs. In fact the aerial surveys only recorded 3 guillemots or razorbills compared to 32 from the VPs in this coastal band (9.4%). Possible explanations include by chance the aerial survey transects not capturing as well used areas and/or availability bias, where the rapid aerial surveys cannot detect birds that are diving. If the latter, this suggests maybe a tenth of birds of these species may be available for any instantaneous snapshot.

4.121 Figure 144 shows the estimated densities of black guillemots from the April to July VP counts around the Butt of Lewis. These show a similar pattern to razorbills, with highest densities within 0.5km of the coast and no steep decline in detectability out to 1km suggesting a true near shore distribution. A count of 17 birds gave a peak density of 4.4 birds km^{-2}. No black guillemots (or unidentified auk species) were recorded in the corresponding aerial survey transect segments again suggesting either chance differences in areas covered excluded them from the aerial survey coverage, or the high proportion of time spent in dives by this species made them unavailable for recording by digital aerial survey.

4.122 Very few puffins were recorded, with a peak of 4 recorded 1km from the vantage points producing a peak density of 0.8 birds km^{-2}. Lower numbers were recorded up to 2km from the VPs (and coast). With such small sample sizes patterns cannot be confidently determined, however the low densities of puffins estimated between 0.5 and 1.5km from the coast from aerial survey records suggests this species which in contrast to guillemot, razorbill and black guillemot does not breed on the north of Lewis may have a more widespread coastal distribution here.

4.123 Figures 147 to 151 (Appendix I) show the densities of records from the west coast vantage points (from Aird Dell south) and corresponding aerial survey transects. In contrast to Figure 143, Figure 147 shows that the 29 guillemots recorded were widely distributed from 0.5 to 2km from the coast (and vantage points) with the peak density of 0.6 birds km^{-2} occurring 2km from the coast. Though it is impossible to tell if this is an undercount due to distance from vantage point, it does at least show that the species can be regularly recorded at this distance which provides greater confidence in the distribution patterns discussed for birds around the Butt of Lewis above. Very few guillemots were recorded from aerial surveys for comparison with more records of large auks or

unidentified auk species. The former of these showed an increase in densities further from the coast with a peak density of 0.45birds km^{-2} at 2km, a similar pattern to that produced from the VP estimates.

4.124 Like guillemots, razorbills also showed a more offshore peak in densities compared to around the Butt of Lewis with a peak of 1.1 birds km^{-2} at 1km from the coast (Figure 148). This is higher than the peak density for guillemots, which is the opposite of around the Butt of Lewis colonies. No razorbills were recorded in the corresponding aerial survey transects so direct comparisons cannot be made. Records were made of large auk species (guillemots or razorbills) but comparisons are complicated by the recording of unidentified auk species also, which could include guillemots and razorbills. Thus comparison will be made of all auk densities combined following black guillemot and puffin below.

4.125 As with VP count data from around the Butt of Lewis, Figure 149 shows highest densities of black guillemots up to 1 bird km^{-2} within 0.5km of the VPs (and coast) from the west coast VPs with much lower densities further offshore. Again, no black guillemots were recorded from the corresponding aerial survey transects so distribution comparisons cannot be made, however of note there were no unidentified auk species recorded either which suggests that the black guillemots (of which 17 were counted from VPs within 0.5km of the coast) were not available for recording in the aerial survey transects either due to location or diving (there were also no records of unidentified small birds which is a category that would 'catch' potential confusion with e.g. a small gull).

4.126 Eight puffins were recorded from west coast VPs compared to 13 from around the north. Again the peak density of 0.4 birds km^{-2} occurred between 0.5 and 1km from the coast (and VPs) suggesting a less near shore distribution compared to black guillemot. Few puffins were recorded in aerial surveys with a peak density of 0.08 birds km^{-2} between 1km and 1.5km from the coast.

4.127 Figure 151 shows a comparison of auk densities derived from vantage points records with those from aerial surveys along the west coast section. For the west coast vantage points comparison of densities at the level of auk species is required due to the complication of unidentified auks recorded during the aerial surveys. The figure shows the VP counts consistently recorded higher densities of auks in all distance bands from the coast with a peak density of 1.4 birds km^{-2} at 0.5 to 1km from the coast compared to 0.7 birds km^{-2} from aerial surveys in the same band.

4.128 In contrast to these breeding season densities, aerial survey counts between September and February yielded higher densities of auks along the west coast than the vantage points, both overall and in all distance from coast bands apart from 0km to 0.5km (Figure 152). The majority of VP records were of black guillemots, which to some extent explains the predominantly near shore highest densities recorded from the VPs while the peak in the 1km to 1.5km distance band suggests detection was reasonable at least out to this distance. A possible explanation for this reversal in densities is that some VPs were not covered in the winter months (see Table 2, Appendix II) and that the sea state was a 4 or 5 during the February 2013 surveys which would have made auk

detection much more difficult from the shore as opposed to from the aerial survey video frames. Overall sample sizes were also small in these months so chance differences between the two timings or locations may have had a greater effect. A similar comparison for winter months around the Butt of Lewis was not practical due to very few records from VPs during these months, again perhaps due to poor sea state.

4.129 Very few records of shags and divers were made during the aerial surveys so the analyses completed above for auks were not completed for these species. It is likely that the fewer aerial survey records are due at least partly to the increased availability of these species for vantage point counts over approximately 30 minute counts compared to the near instantaneous recording during the digital surveys.

5. Discussion

5.1 The last previous boat or aerial surveys of the north west coastal waters of Lewis were undertaken pre-1990, over 20 years ago. The aerial and vantage points surveys from seven surveys covering the most important periods of the year for Scottish seabirds presented here are therefore valuable in supporting our understanding of the distributions and abundances of seabirds in this area.

5.2 The combined approach of aerial surveys and ground counts enabled good spatial coverage of sampling across the area and more detailed data on selected coastal locations, in particular the whole of Loch Roag.

5.3 By accurate georeferencing of objects in video images the relative use by seabirds and marine mammals of proposed wave/tidal sites can be assessed, while the application of density surface modelling enables estimation of species densities within these sites. Of those species identified as most vulnerable to the impacts of tidal turbines (Wilson *et al*. 2007, Furness *et al*. 2012) great northern divers, red-throated divers, black-throated divers, cormorants, shags, guillemots, razorbill, puffins, minke whale, harbour porpoises, white-beaked dolphin and grey seals were all recorded using the proposed renewable development sites though in relatively small numbers compared to breeding site populations within foraging range. Diver species in winter were shown to exceed national 1% levels, though identification was generally to species groups rather than species. Black guillemots were also recorded in the coastal development sites from the ground-based counts.

5.4 Comparison between records from the Vantage Point counts and the aerial surveys was completed within the areas covered by both survey techniques. Fulmar and gannet distributions and numbers were similar between the two methods, though data were also collected on flying birds in the aerial surveys.

5.5 In all months there was little overlap in distributions or identifications of gull species. Sample sizes were too small to detect any trends in identification but it is likely that differences in records were due to the highly mobile nature of these species.

5.6 The ground counts recorded larger numbers of diver species (red-throated divers, black-throated divers and great northern divers), shags and black guillemots overall and in coastal areas higher numbers of guillemots, razorbills and puffins, though comparisons of these species were complicated by the use of species groups in the aerial survey data.

5.7 On a fine scale the overlap of records was too imprecise to allow verification of individual birds, which could move relatively large distances over very short spaces of time. The data were therefore summarised as densities in coastal distance bands which was more robust to these spatial and temporal differences. The results of these comparisons highlighted some interesting patterns with aerial surveys recording around 10% of guillemots and razorbills combined compared to Vantage Points in the summer around the Butt of Lewis, but the percentage had increased to 20% between all auk species combined in the summer along the west of Lewis and in the winter aerial surveys recorded twice the number of auks in these west coast 2km bands. For the former two results, where aerial surveys had recorded lower numbers of auks it is possible that availability of birds was a contributing factor, where diving birds could not be detected in a near instantaneous aerial survey but would surface during the vantage point count duration. Studies in the Baltic have shown that breeding guillemots spent around 34% of their time at sea under water in dives (Evans *et al*. 2013) and breeding razorbills around 16% (Benvenuti *et al*. 2001). From these data we may thus expect instantaneous surveys to record around 34% fewer guillemots and 16% fewer razorbills than longer scanning searches such as from VPs. Undoubtedly such availability has a contributing effect and will also help explain the greater numbers of shags and divers recorded during vantage point counts. However the even fewer auks recorded from aerial surveys than dive data would predict combined with the reversal of recorded auk densities between the two methods in the winter suggests further study is required to explore differences between the methodologies with greater sample sizes.

Future recommendations

Ground-based counts of Loch Roag

5.8 A single day does not give sufficient time to cover the inner Loch Roag as thoroughly as would be ideal. A single day results in gaps in coverage and probably exacerbates under-recording because surveyors are inevitably in a rush to move on to the next counting point. With a one-day single-observer method there is insufficient time to walk out to some additional vantage points that give views over the areas that were not covered. It is recommended that in future a visit is spread over two people days. One day to cover Great Bernera and the eastern sectors, and the other day to count Little Loch Roag, and the western sectors up to Valtos. The January and February counts were undertaken over two days and achieved better coverage as a result.

5.9 Seals were counted irrespective of tide state. It was good fortune that the low tide period coincided with counting on the April and July visits. Data collected to date suggests an uneven distribution of species of high conservation importance. However, at least one more year of data would be required to be confident that the observed patterns were consistent. Identifying areas of

consistently high value to importance species is important for informing site designations and case work such as renewable energy and aquaculture proposals.

5.10 The 2012 surveys did not aim to link birds seen during the breeding season to breeding sites. A small amount of information on breeding sites was gathered incidentally in 2012, principally for terns and cormorants. Determining the size and location of colonies in Loch Roag of cormorants, shags, tern species and black guillemots during future fieldwork would be valuable.

Aerial survey and ground count comparisons

5.11 This project identified differences in the numbers of birds and hence densities of particularly diving birds recorded from vantage point counts and digital aerial surveys. Though attempt was made to explore these differences the small sample sizes precluded conclusive trends to be determined. Similar studies on waters supporting higher densities of auks and/or shags would yield larger sample sizes with which to compare the methods and determine sources and scales of discrepancies. It should be borne in mind that camera technologies are continually being improved and it is possible that auk identification and possibly detection rates may improve with this.

Ground-based counts - Loch Roag priority bird species

Red-throated diver

5.12 Inner Loch Roag was shown to have high importance for summering red-throated divers, many of which are likely to be breeding locally (Tables 14, Appendix II Figure 88, Appendix I). At least 39 were present in April and at least 26 in July. Allowing for gaps in survey coverage, possible under recording and that around half of breeding individuals are likely to be at breeding sites at the time of survey work, it is likely that inner Loch Roag provides feeding for in the region of 80 individuals through the breeding season. These are likely to comprise a mix of breeding birds and immature non-breeding birds, with the former likely to form the majority. The UK breeding population is approximately 1,255 pairs. If Loch Roag provided feeding for 25 pairs, this would represent in the region of 2% of the UK breeding population.

Black-throated diver

5.13 The regular occurrence of black-throated divers in the spring and summer is of note as this species has a small population size (Table 15, Appendix II and Figure 89, Appendix I). It is likely that Loch Roag is an important feeding site for a small number of pairs, probably 1-2% of the UK population. There are at least two regular breeding pairs close to Loch Roag and the birds seen are likely to have been breeding locally and visiting Loch Roag to feed. Numbers increased in the winter with the arrival of wintering birds. The 12 recorded in February represents around 2% of the British overwintering population (Musgrove *et al*. 2011).

Great northern diver

5.14 Inner Loch Roag was shown to have high importance for wintering/passage great northern divers, with at least 95 individuals present in February (Table

16, Appendix II, Figure 90, Appendix I). The low numbers recorded in October were to be expected as this species does not typically return to wintering areas (from sub-Arctic and Arctic breeding grounds) until late October and November.

5.15 There are thought to be around 2500 great northern divers overwintering in British and Irish waters (Musgrove *et al*. 2011), though this is likely to be an underestimate because of poor coverage by national surveys. Allowing for survey coverage and some under recording, it is likely that the numbers using inner Loch Roag in the winter comfortably exceeds 1% of the UK wintering population.

Slavonian grebe

5.16 The occurrence of up to 16 Slavonian grebes in the winter surveys (Table 18, Appendix II and Figure 91, Appendix I) is notable as the size of the overwintering population of this species is small. It is estimated that 339 individuals overwinter in Scotland (Forrester and Andrews 2007) and around 1,100 in Britain (Musgrove et al. 2011), though these figures may be an underestimate as the species is easily overlooked. The numbers overwintering or occurring on passage in inner Loch Roag is in the region of 1% and 5% of the British and Scottish overwintering populations respectively and is therefore of importance.

Cormorant

5.17 Up to 14 cormorants were seen in the breeding season in inner Loch Roag (Table 22, Appendix II, Figure 92, Appendix I). An additional 18 cormorants were seen incidentally on the July visit approximately 2 km north of the survey area, in the outer part of Loch Roag. These 18 birds were on or close to the breeding colony situated at Stac an Tuill, a small isolated stack north of Great Bernera. The numbers seen were almost certainly an underestimate of the total number breeding there as the site is too far offshore to be readily counted from Great Bernera. This is the only cormorant colony on Lewis. The sheltered waters of Loch Roag are likely to provide most of the feeding for birds from this colony. The breeding colony on Stac an Tuill represents approximately 5% of the Western Isles population (Mitchell *et al*. 2004).

Eider

5.18 Moderate numbers (maximum count 275) of eiders over-summer in Loch Roag (Table 28, Appendix II). Females with 18 dependent ducklings estimated to six different broods were found in July, showing that the Loch Roag supports a small breeding population. These are the only eiders known to breed in Lewis.

Arctic tern and Common tern

5.19 Arctic and common terns were present in small numbers (up to 47 and 33 individuals recorded on one visit, respectively) and almost certainly breed on skerries in the 'East Loch Roag' and 'Kyles Pabbay and Valtos' sectors (Tables 40 and 41, Appendix II). The numbers of Arctic terns present are well below 1% of the Western Isles population (4146 pairs). The numbers of common terns present, were they all breeding, would represent around 3% of the

Western Isles population (502 pairs). Common terns were not recorded breeding on Lewis during the Seabird 2000 seabird colony census, so inner Loch Roag would be a new breeding site for this species. Establishing the size and location breeding colonies in Loch Roag should be an aim of future survey work.

Black guillemot

5.20 Up to 55 black guillemots were recorded on a single visit, and these are all likely to have been breeding locally (Table 44, and Figure 94, Appendix I). Allowing for survey coverage and some under recording, it is likely that inner Loch Roag supports in the region of 40-60 breeding pairs. This would represent approximately 2% of the Western Isles breeding population, but well below 1% of the UK breeding population. The survey work did not determine the location of breeding sites.

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APPENDIX I. Figures

Figure 2 – HiDef Quality Assurance Procedure

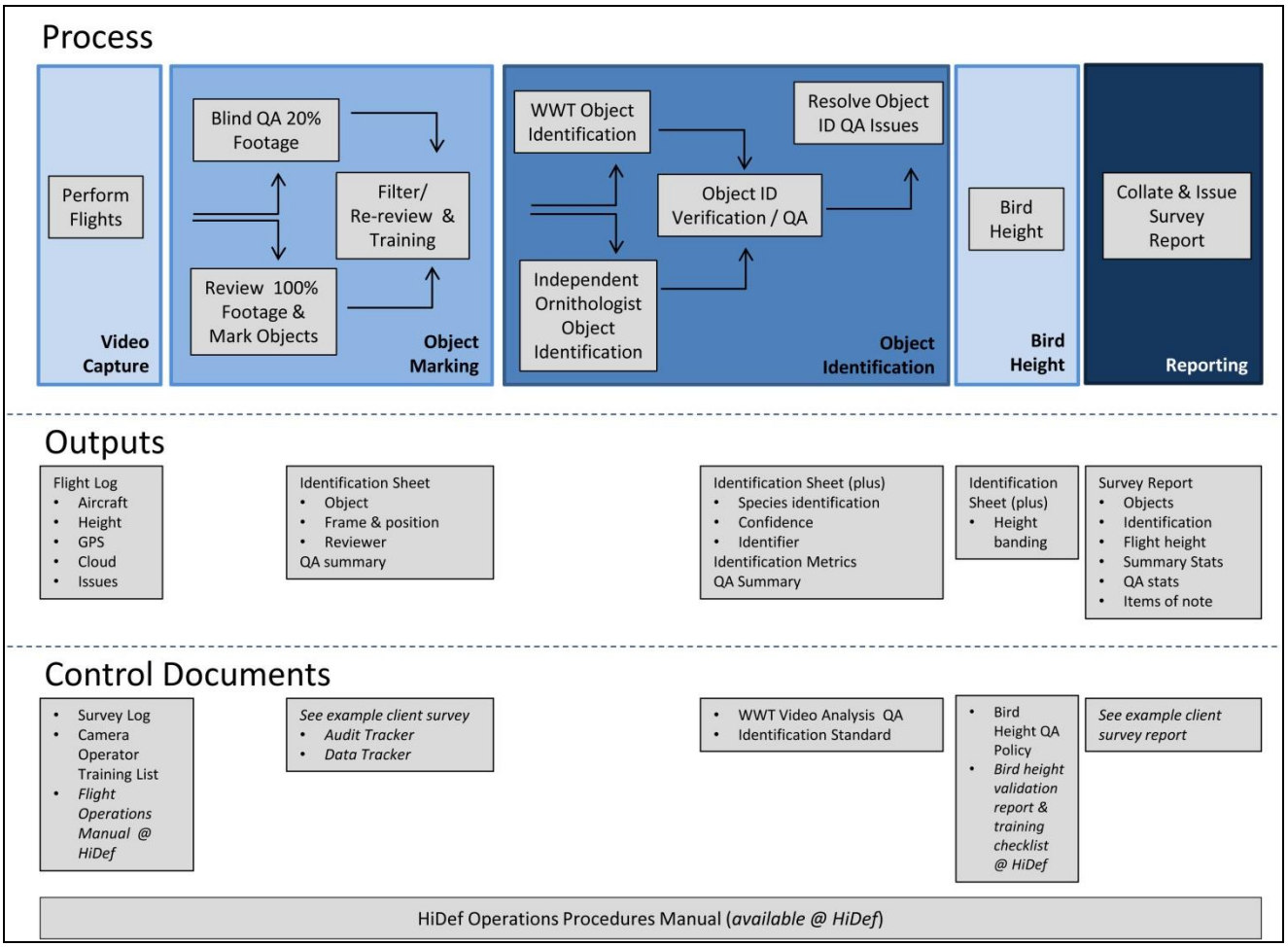


Figure 3 – WWT HiDef Quality Assurance Procedure

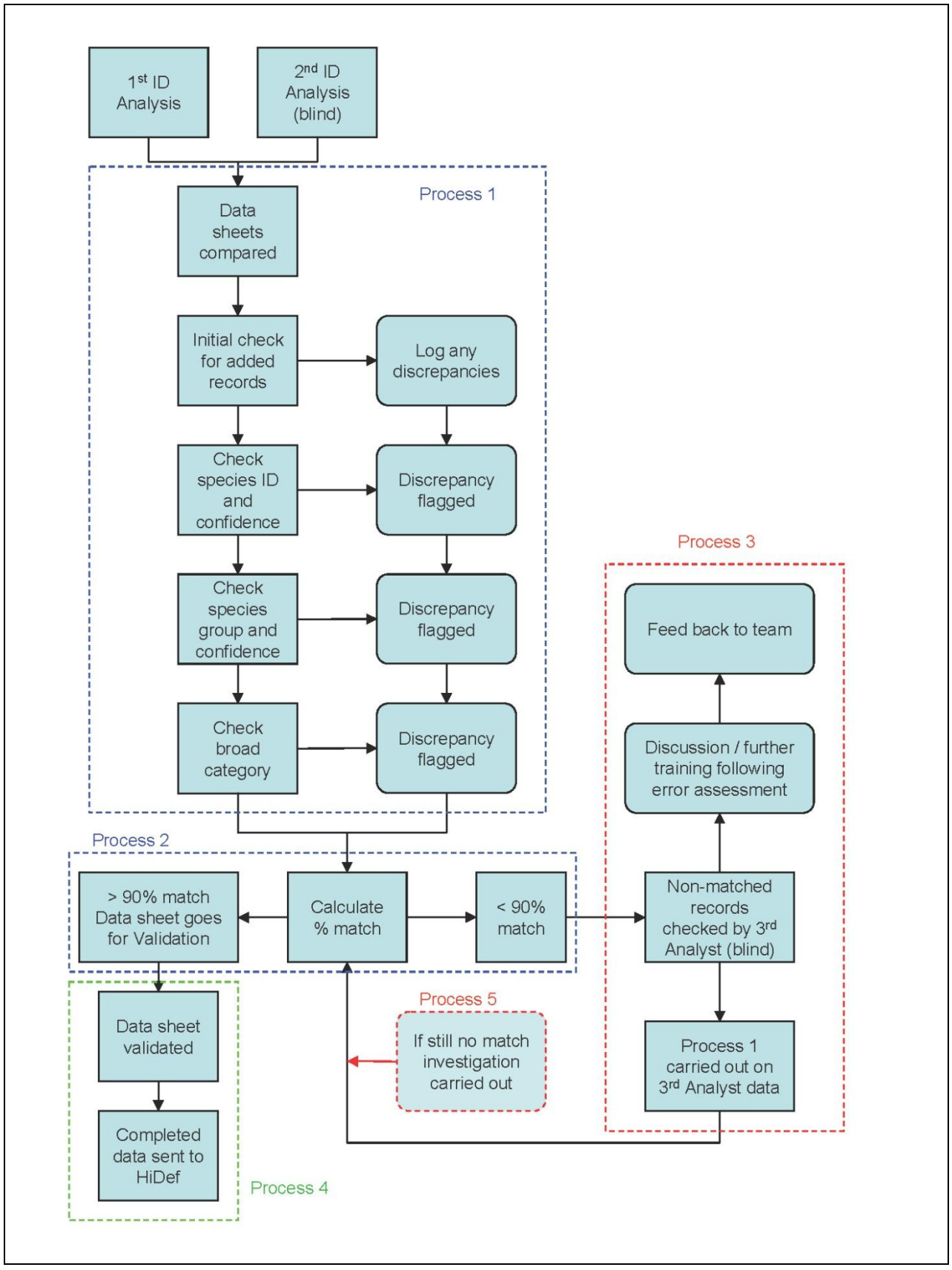


Figure 4 – Loch Roag survey sections

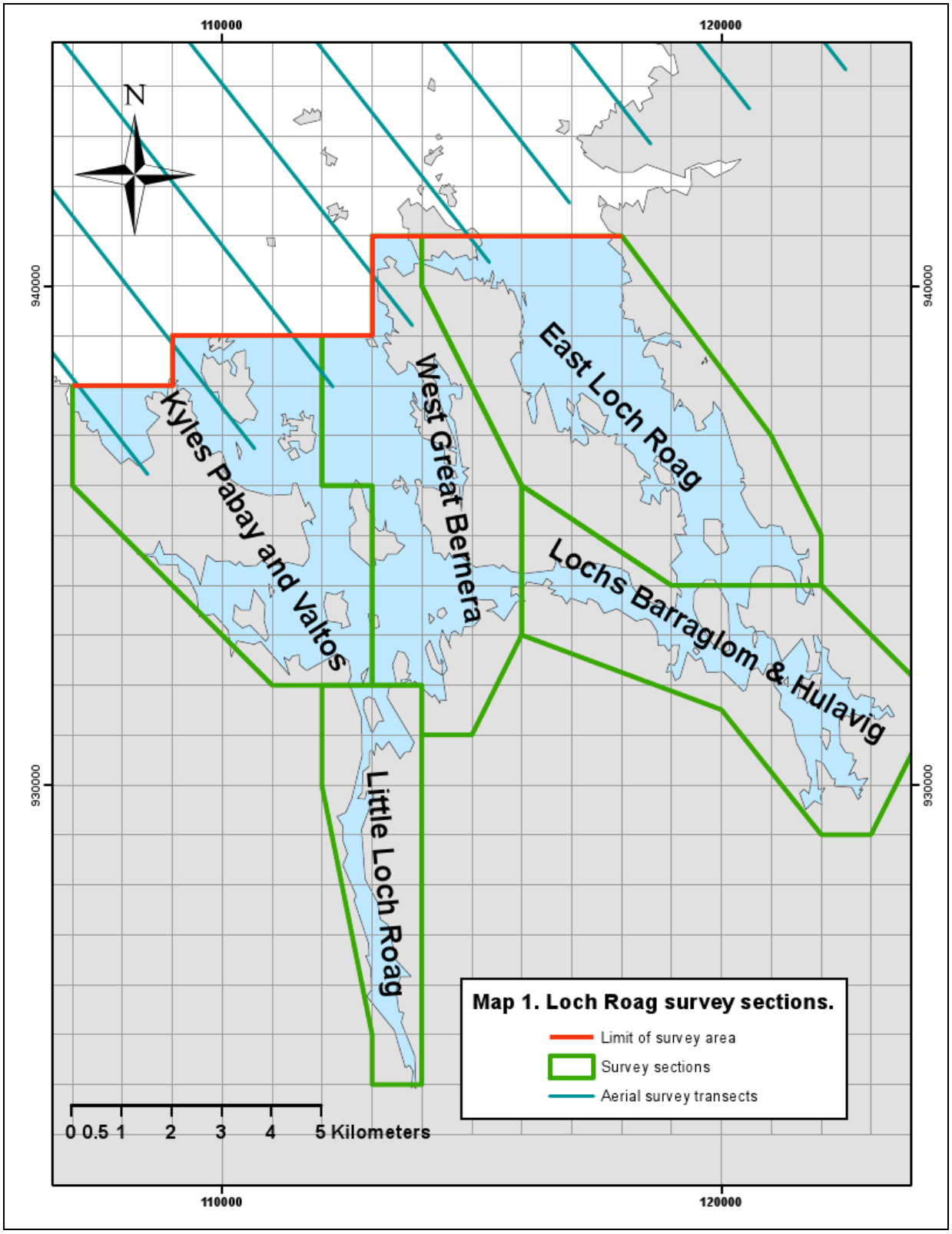


Figure 5 – April eider and diver records from digital aerial survey

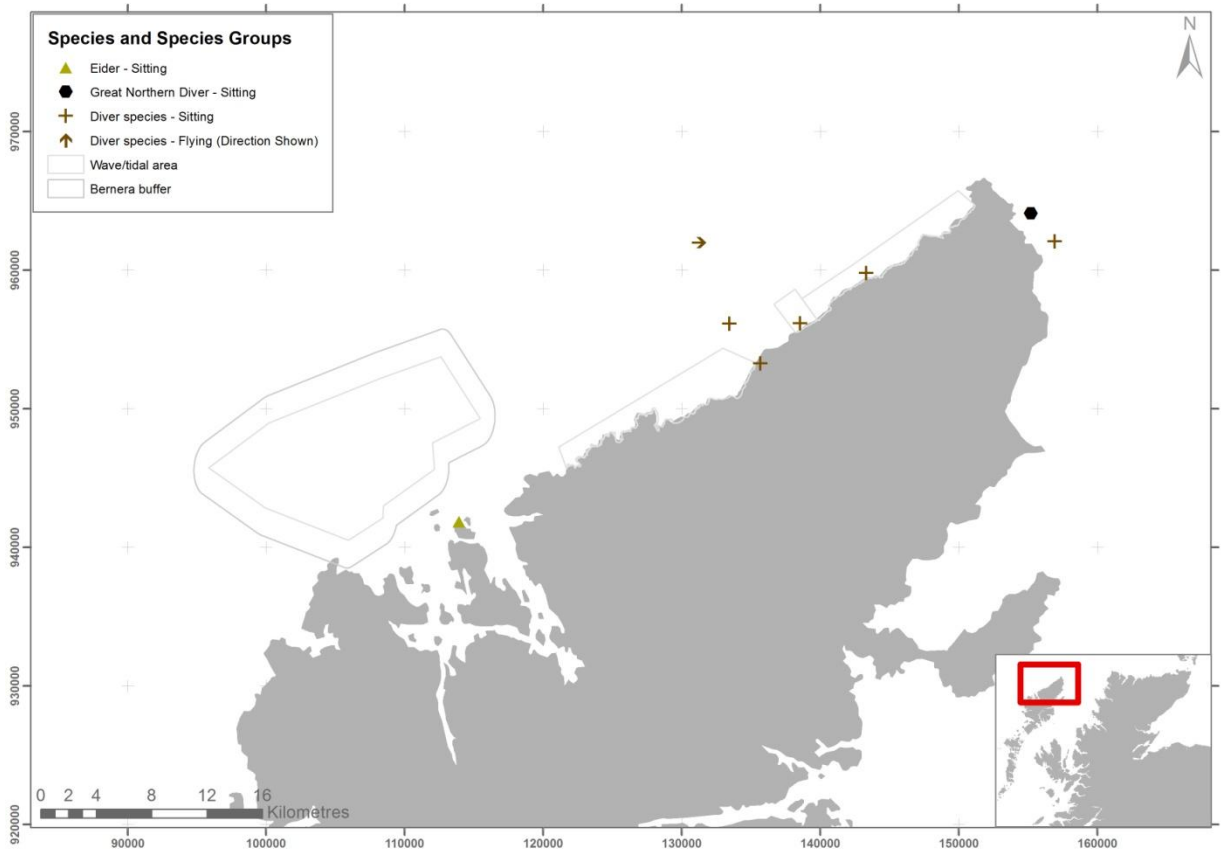


Figure 6 – April fulmar records from digital aerial survey

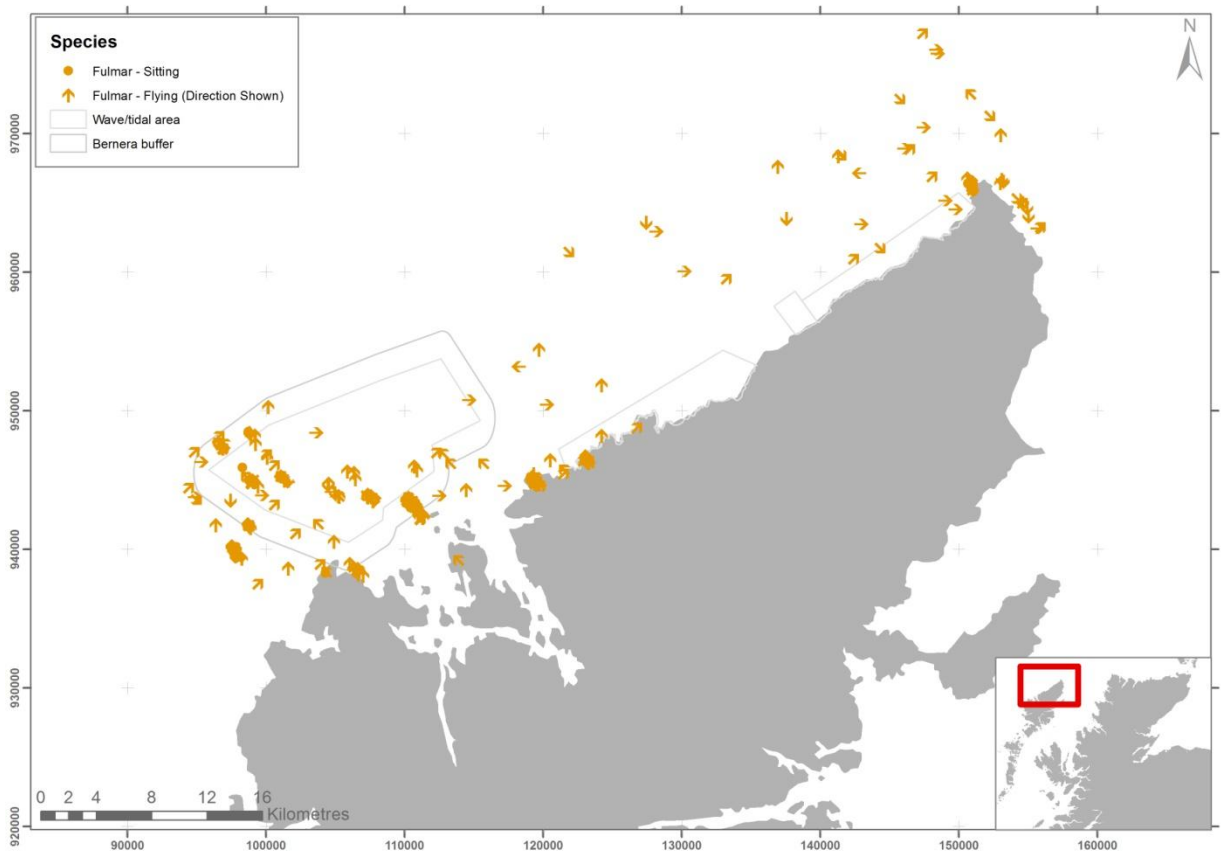


Figure 7 - April gannet records from digital aerial survey

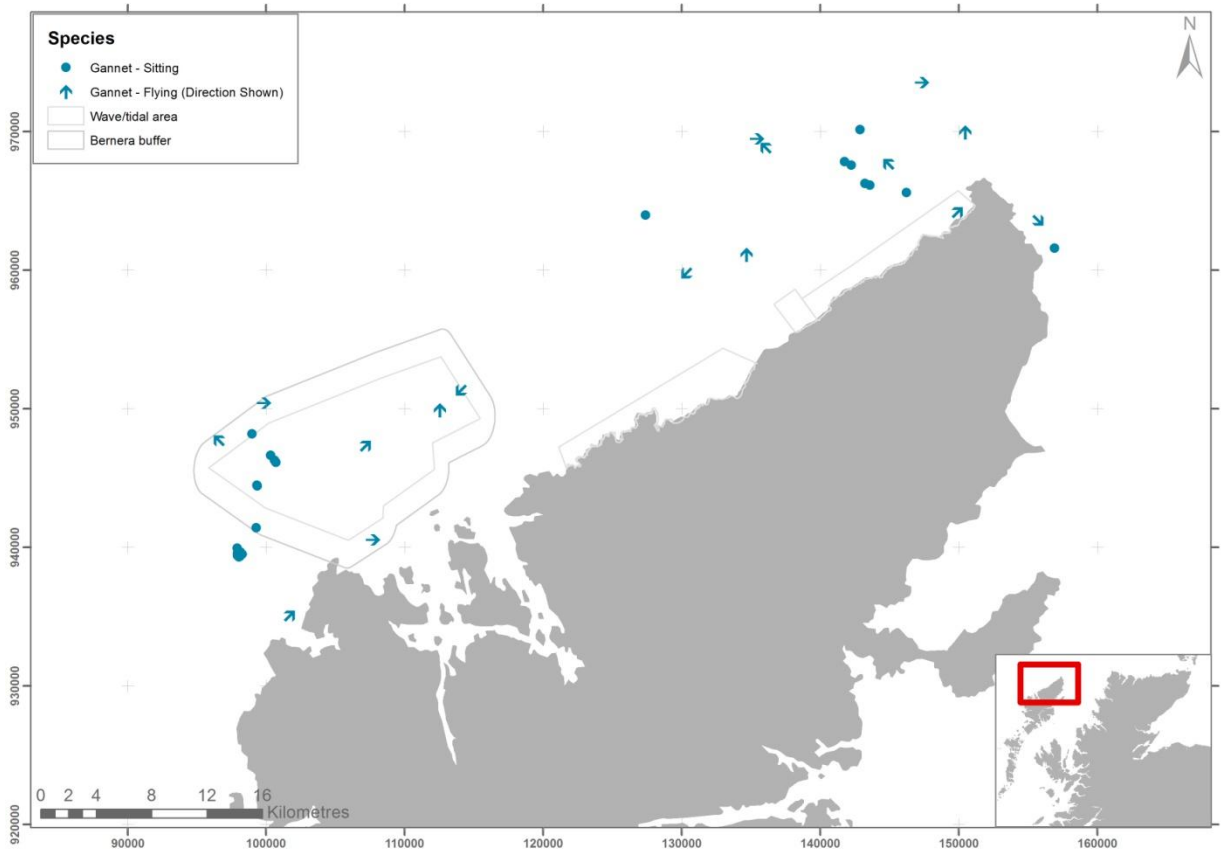


Figure 8 – April gull and skua records from digital aerial survey

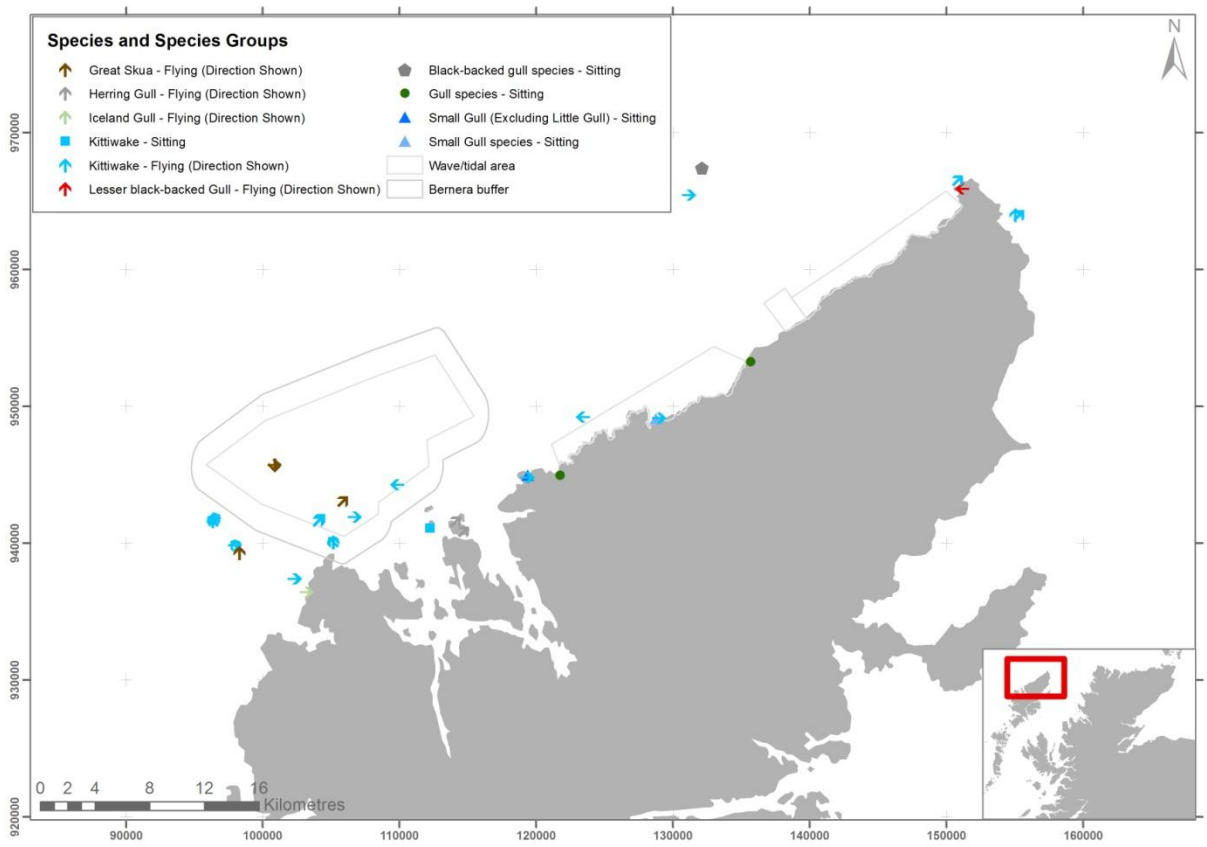


Figure 9 – April auk records from digital aerial survey

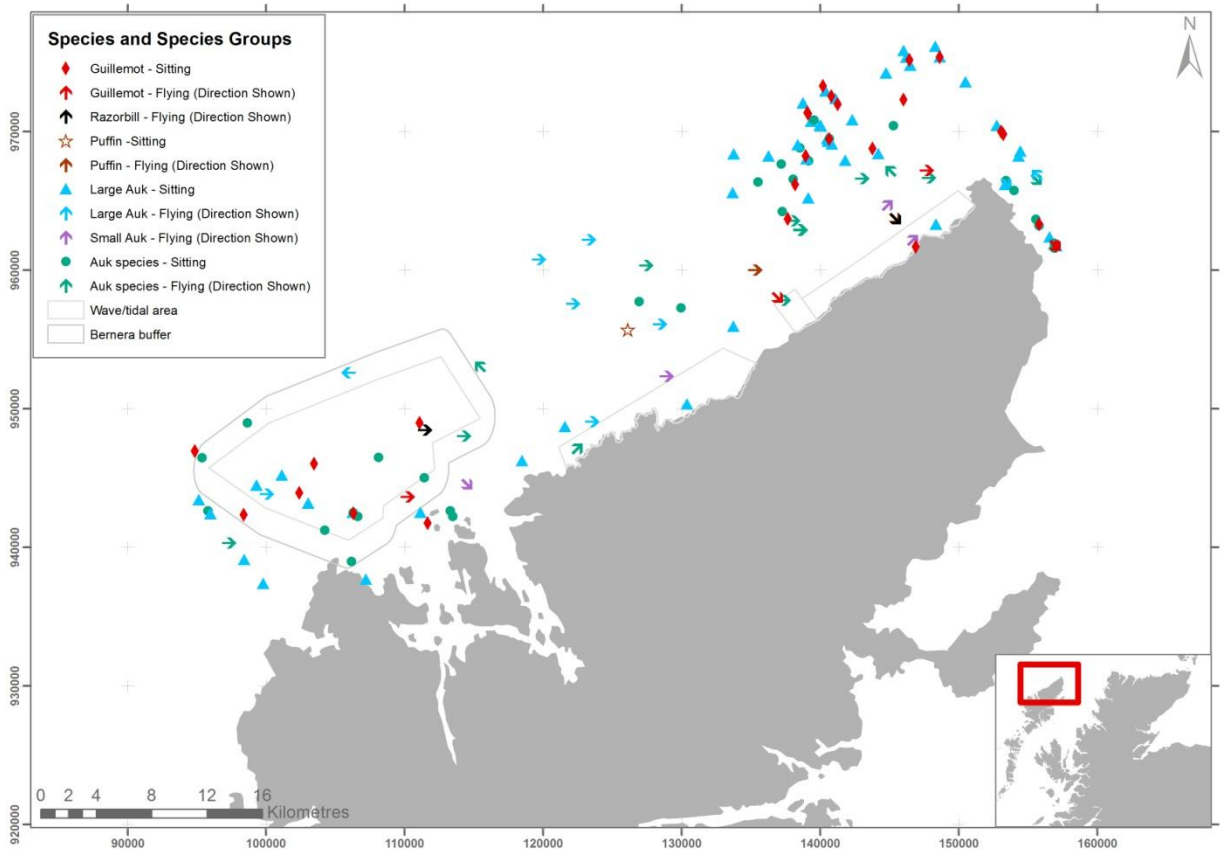


Figure 10 – April cetacean records from digital aerial survey

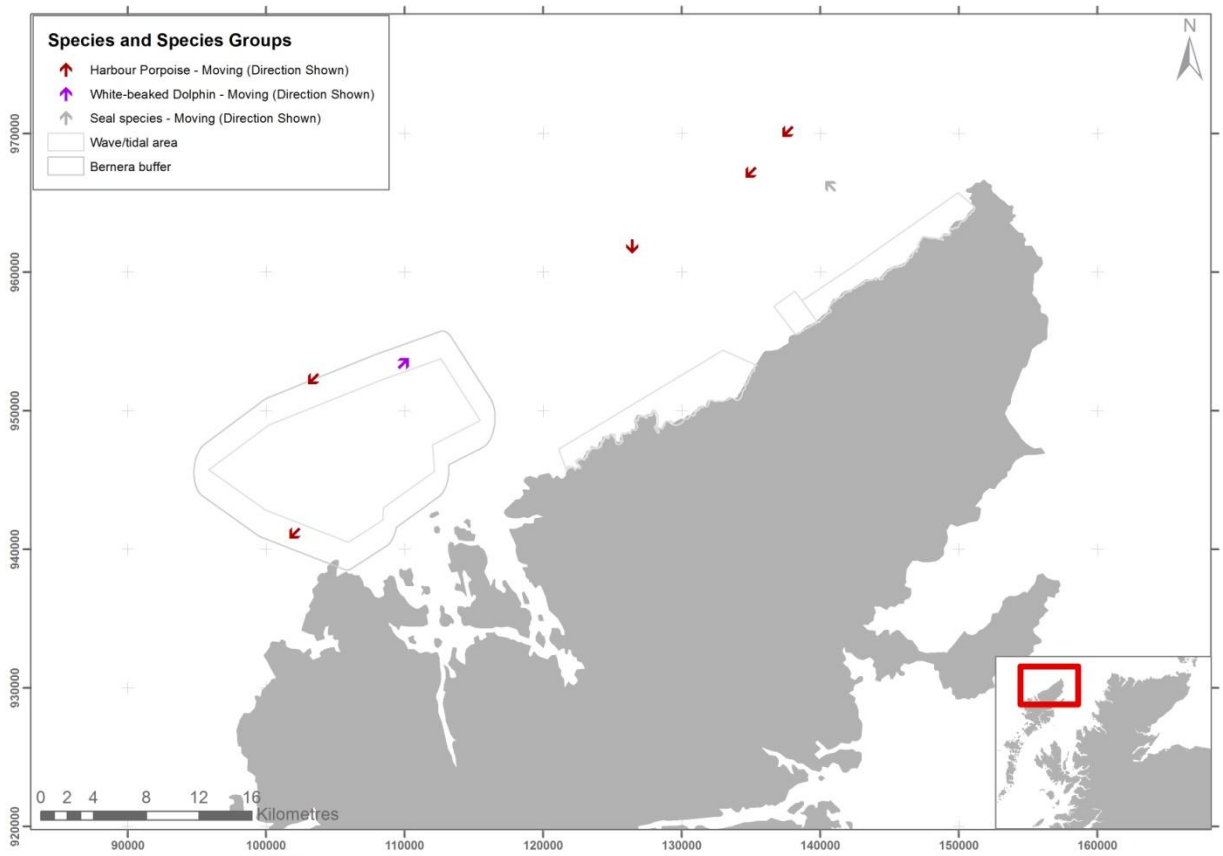


Figure 11 – May eider and shag records from digital aerial survey

Figure 12 – May fulmar records from digital aerial survey

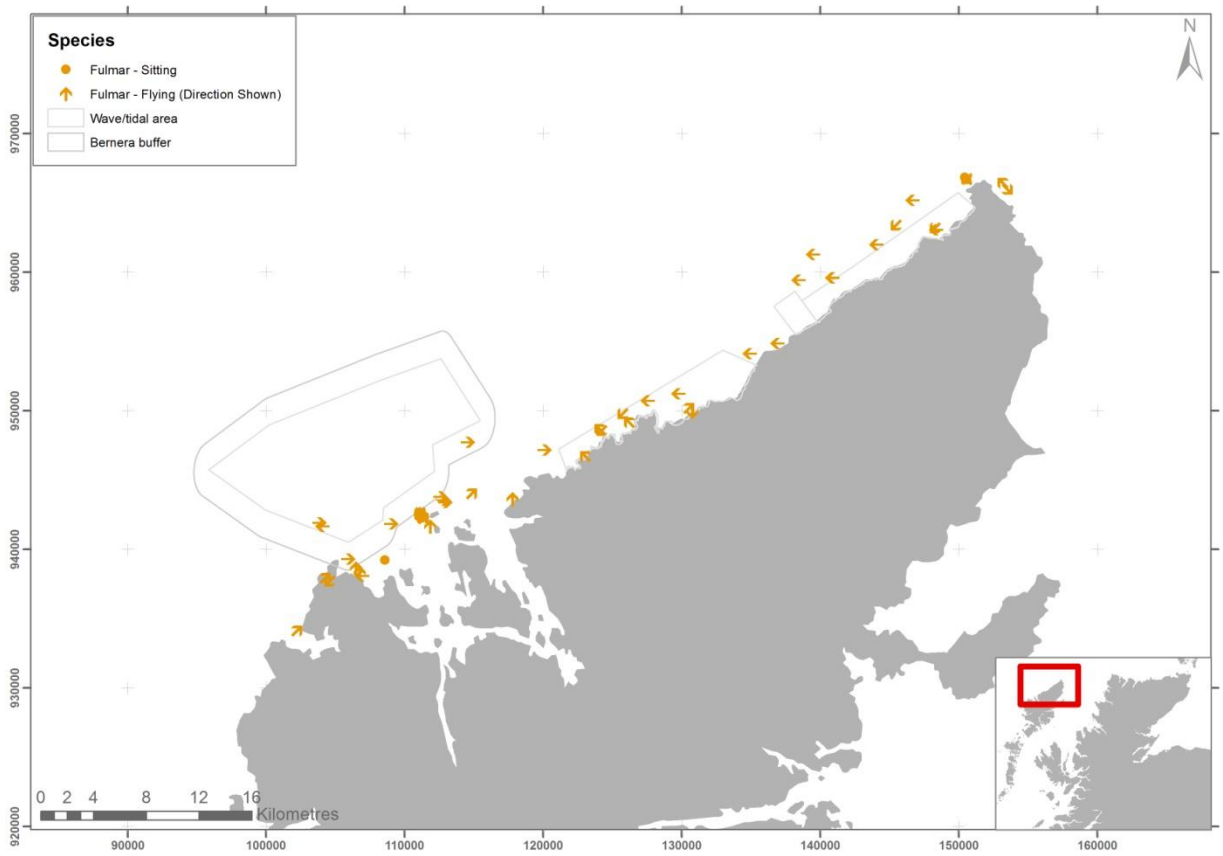


Figure 13 – May gannet records from digital aerial survey

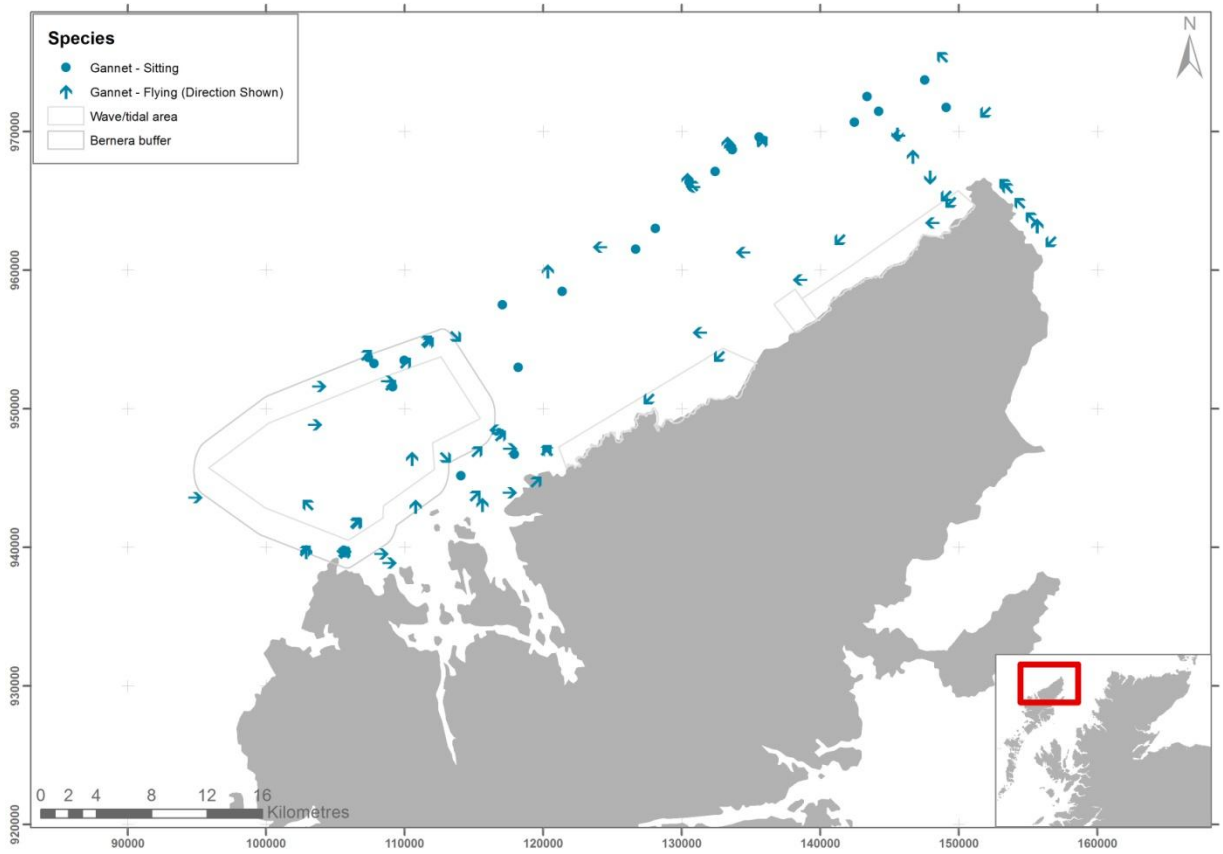


Figure 14 – May gull records from digital aerial survey

Figure 15 – May auk records from digital aerial survey

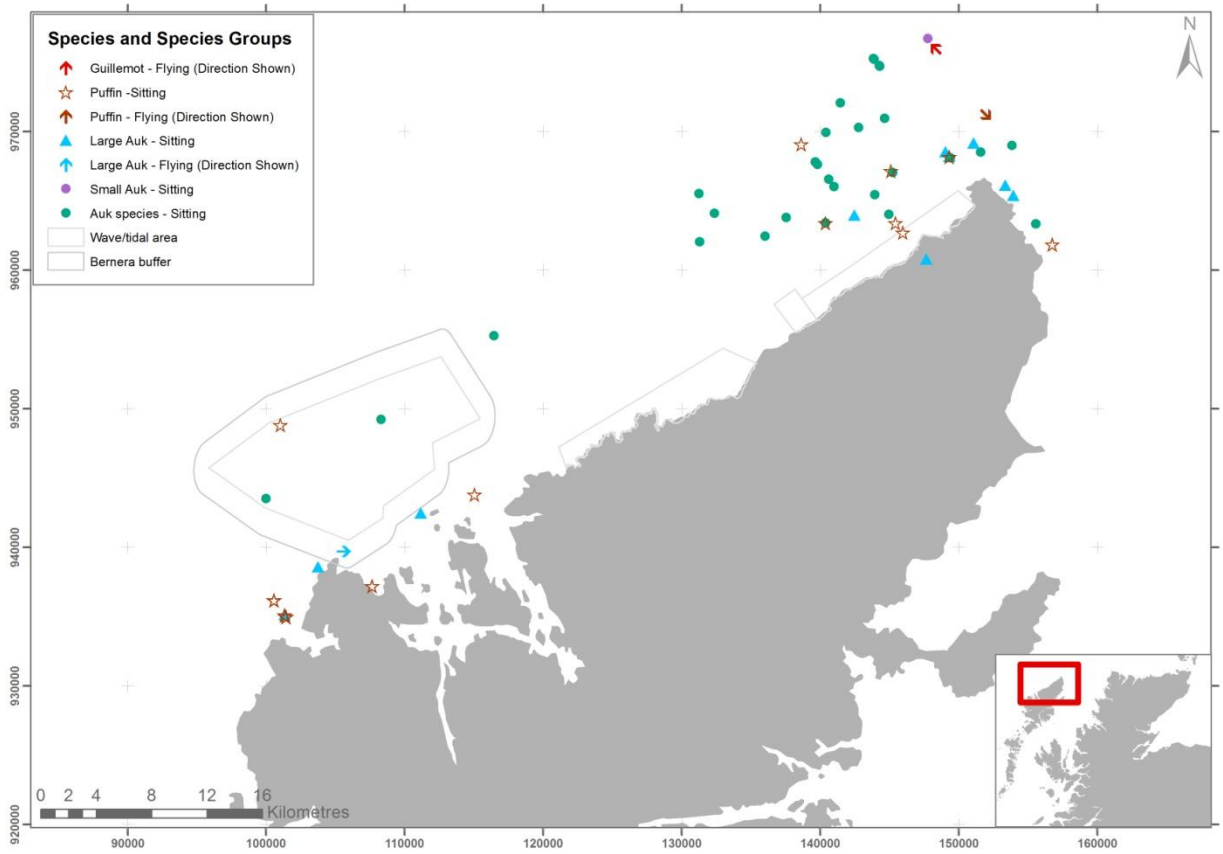


Figure 16 – June duck and diver records from digital aerial survey

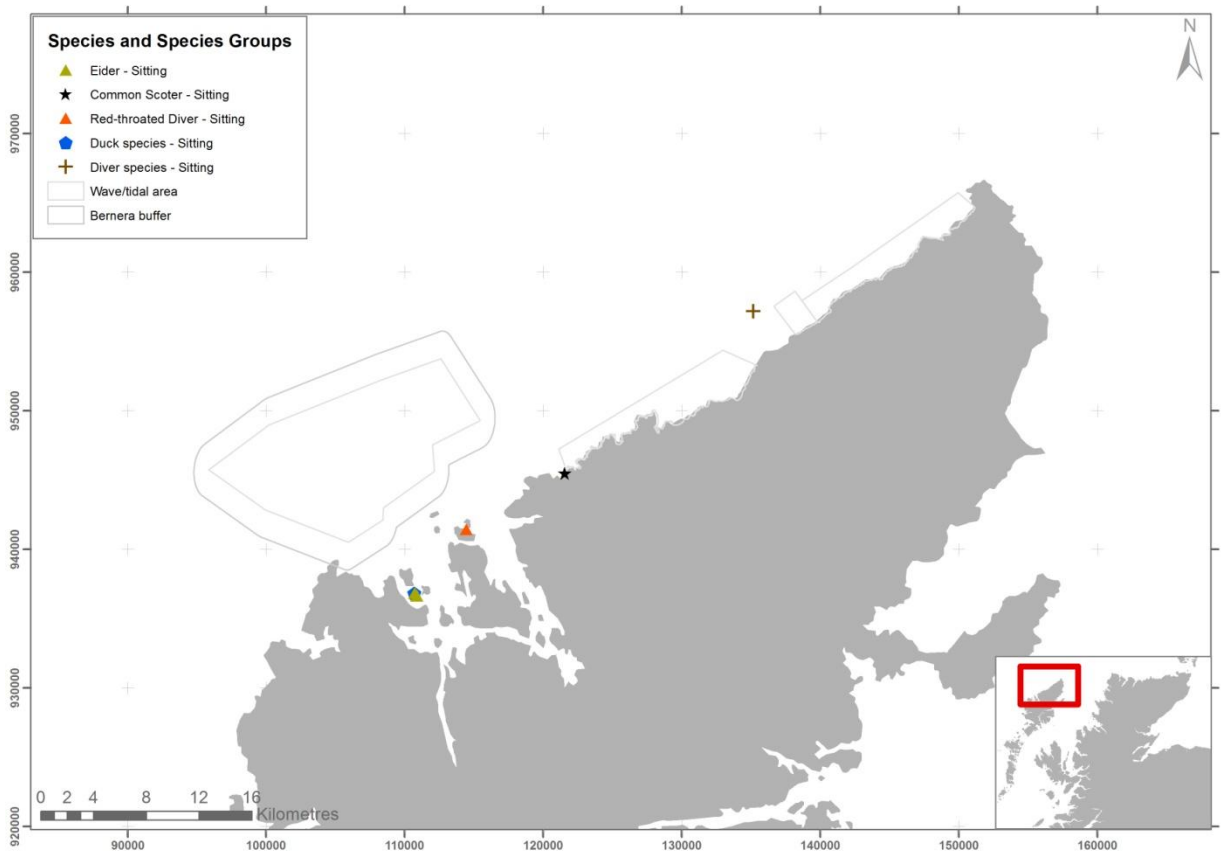


Figure 17 – June fulmar records from digital aerial survey

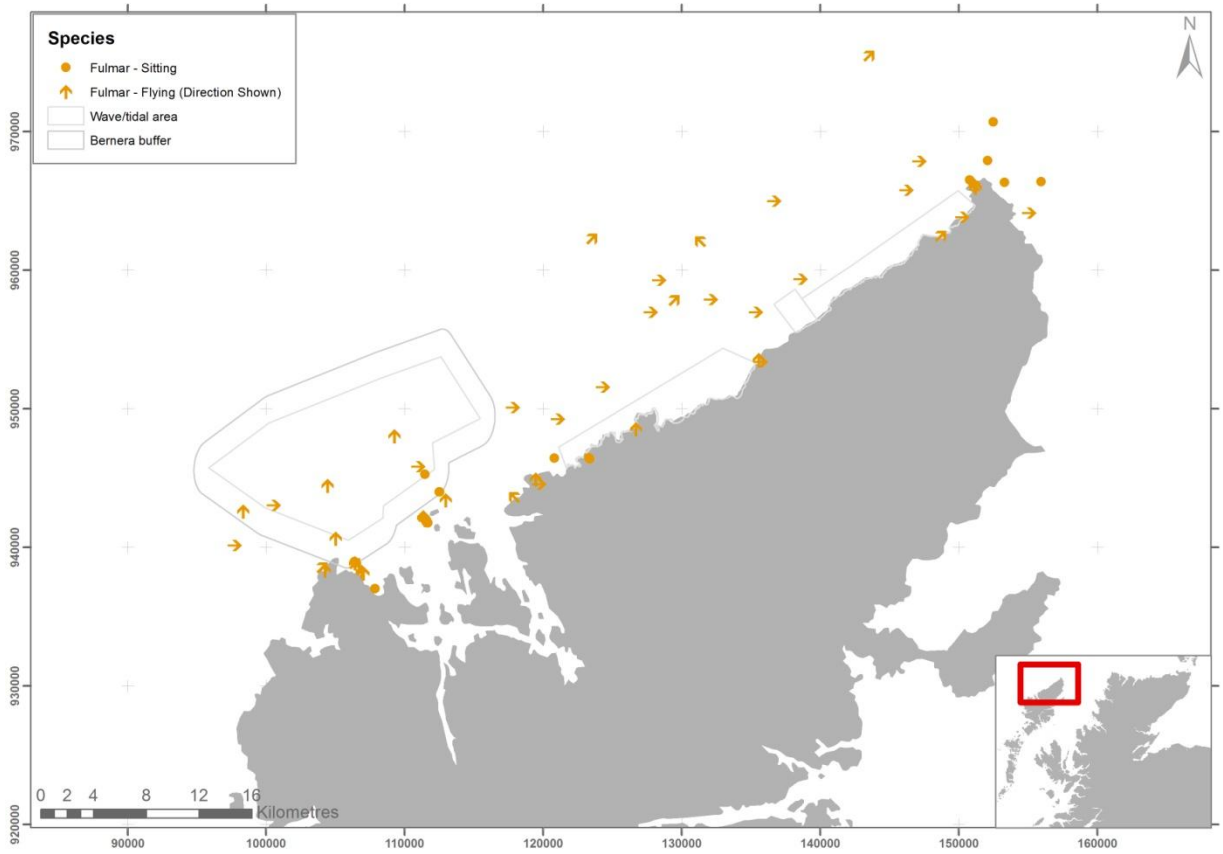


Figure 18 – June gannet records from digital aerial survey

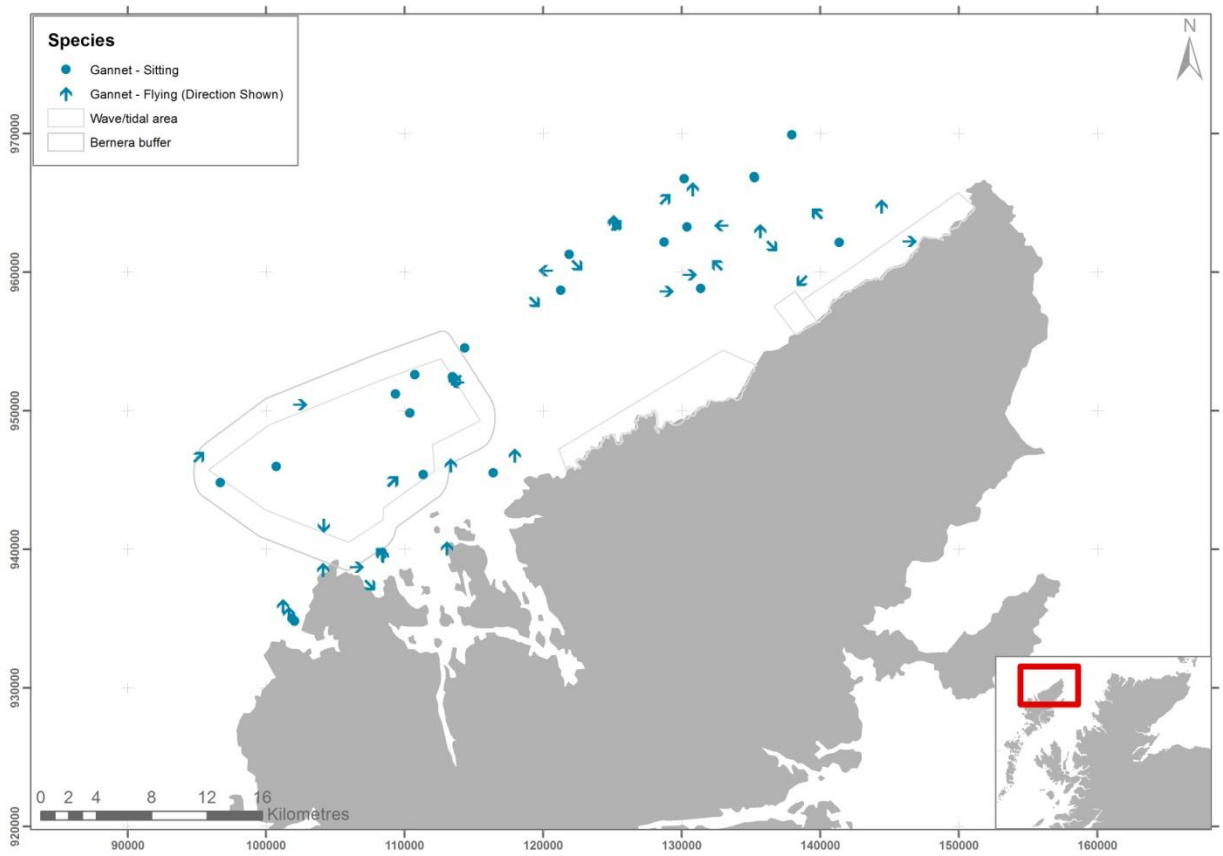


Figure 19 – June gull species records from digital aerial survey

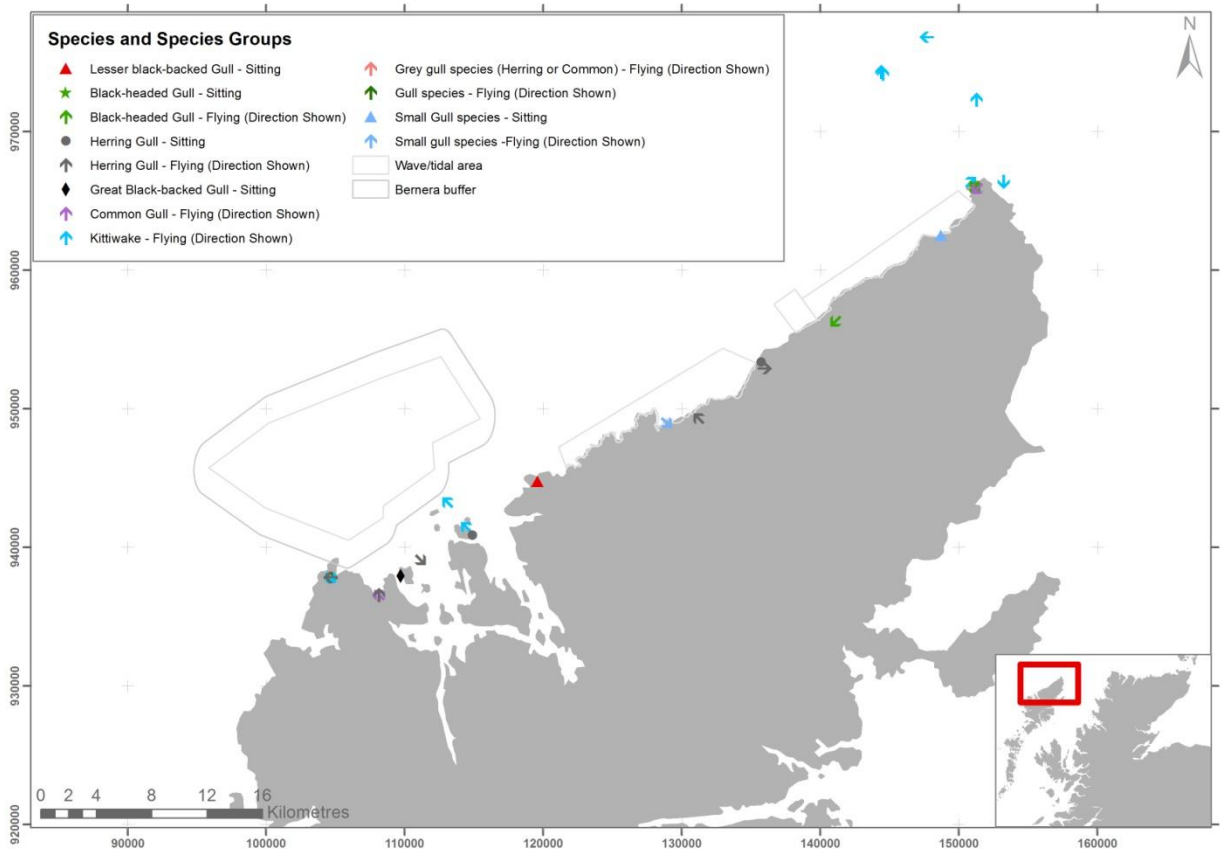


Figure 20 – June auk records from digital aerial survey

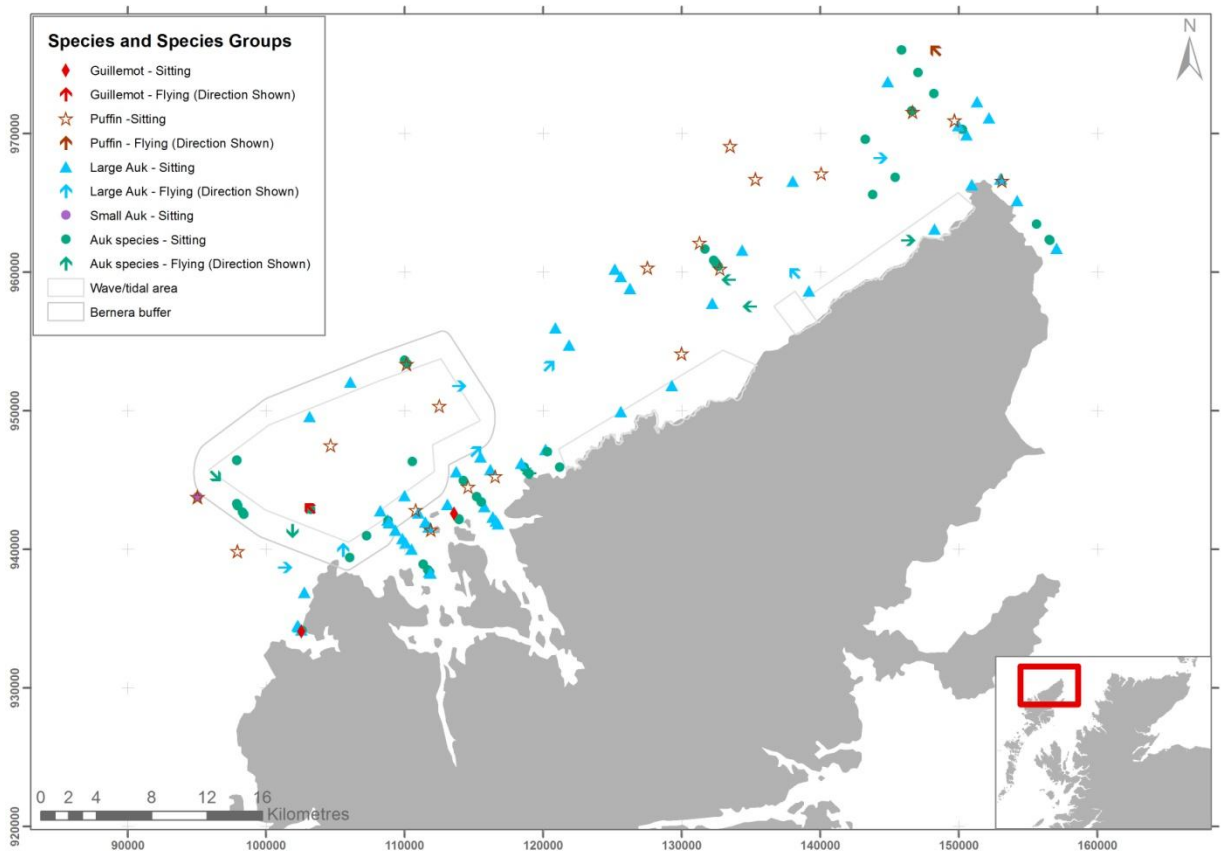


Figure 21 – June cetacean, marine mammal and shark records from digital aerial survey

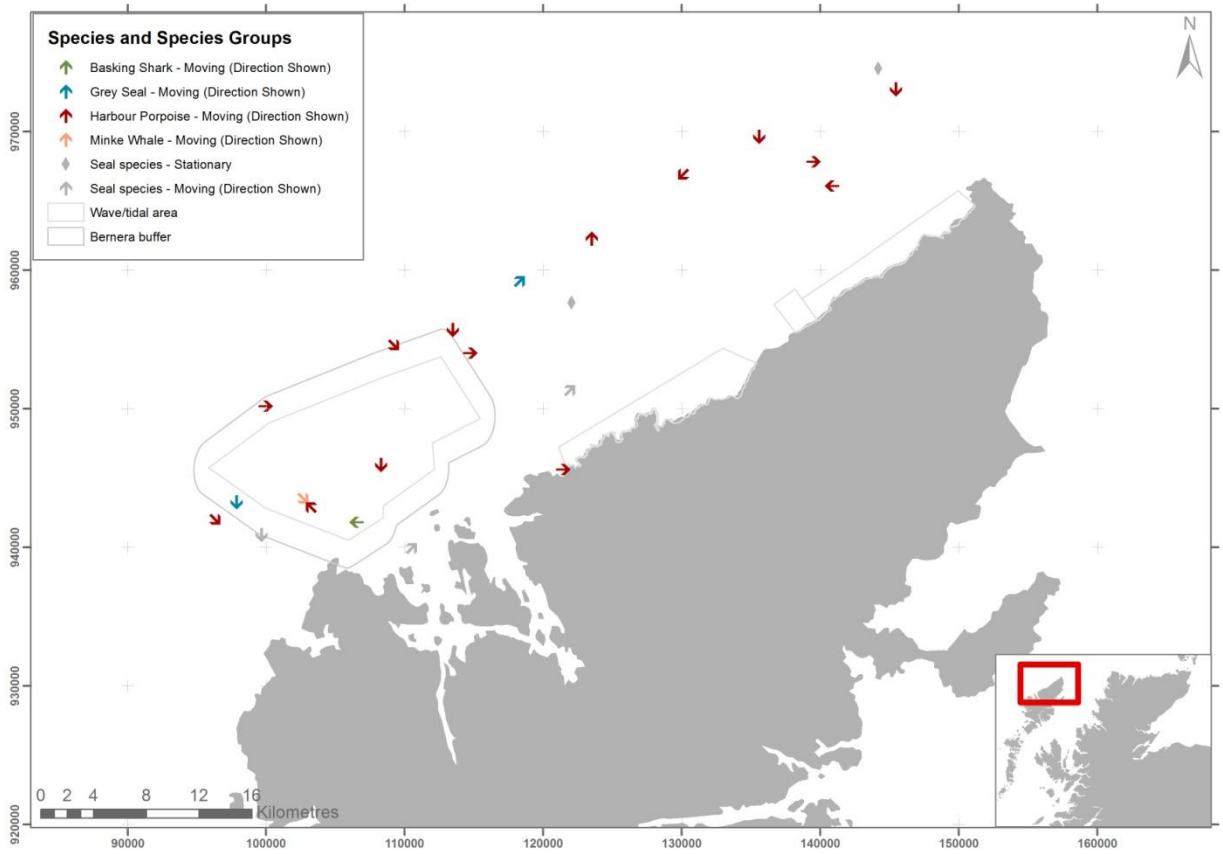


Figure 22 – July shag and duck species records from digital aerial survey

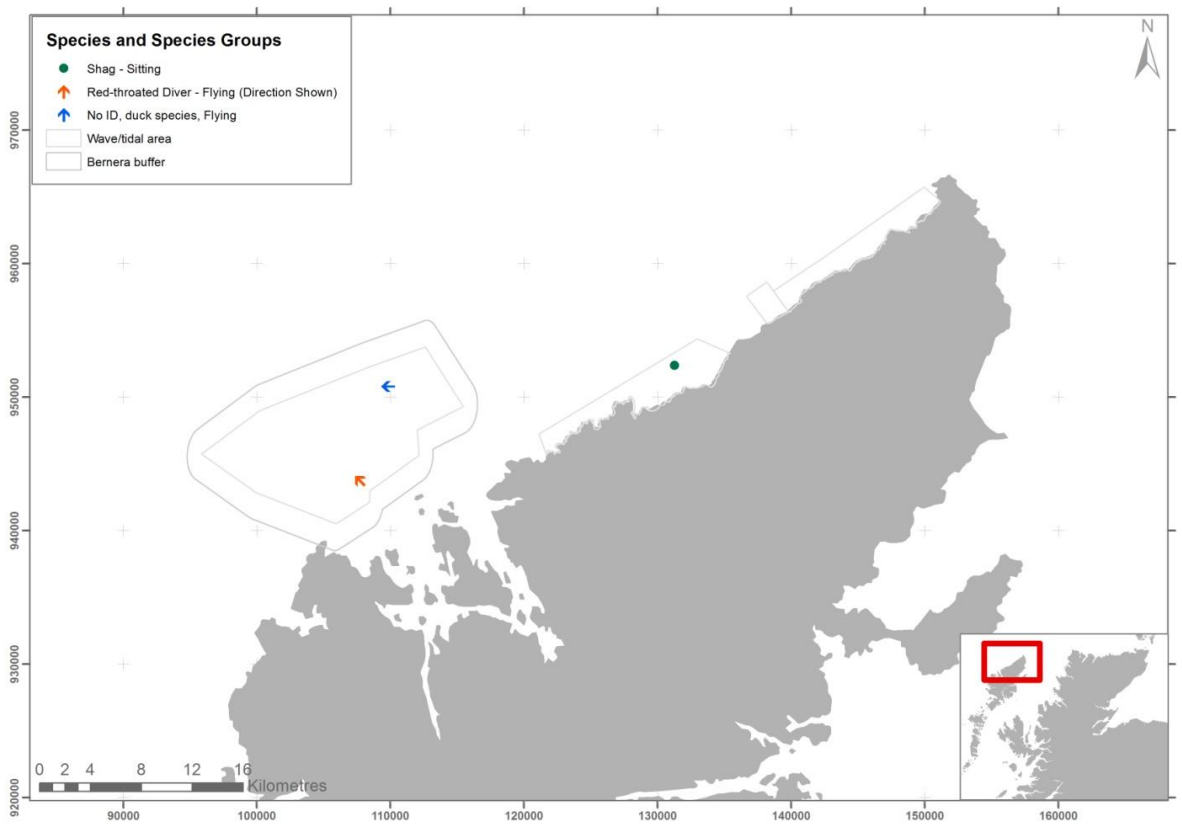


Figure 23 – July fulmar records from digital aerial survey

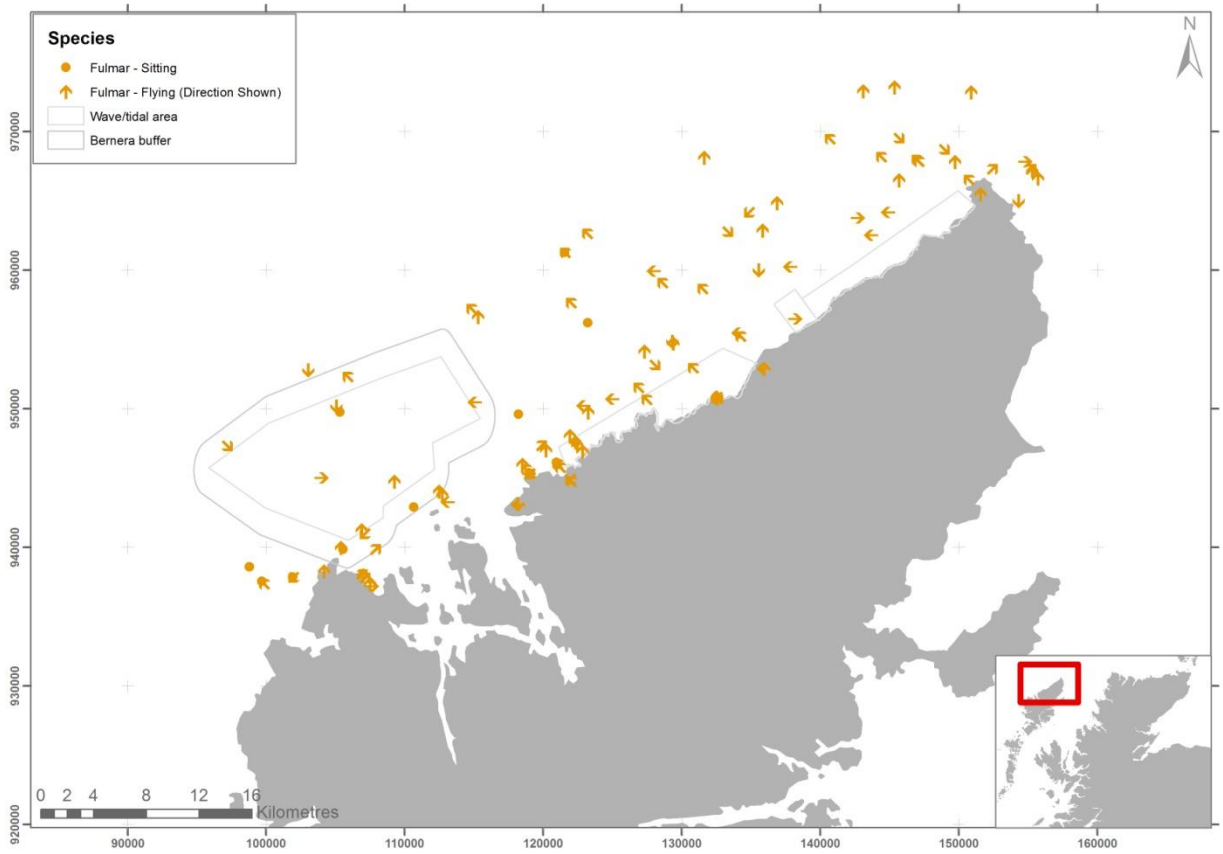


Figure 24 – July gannet records from digital aerial survey

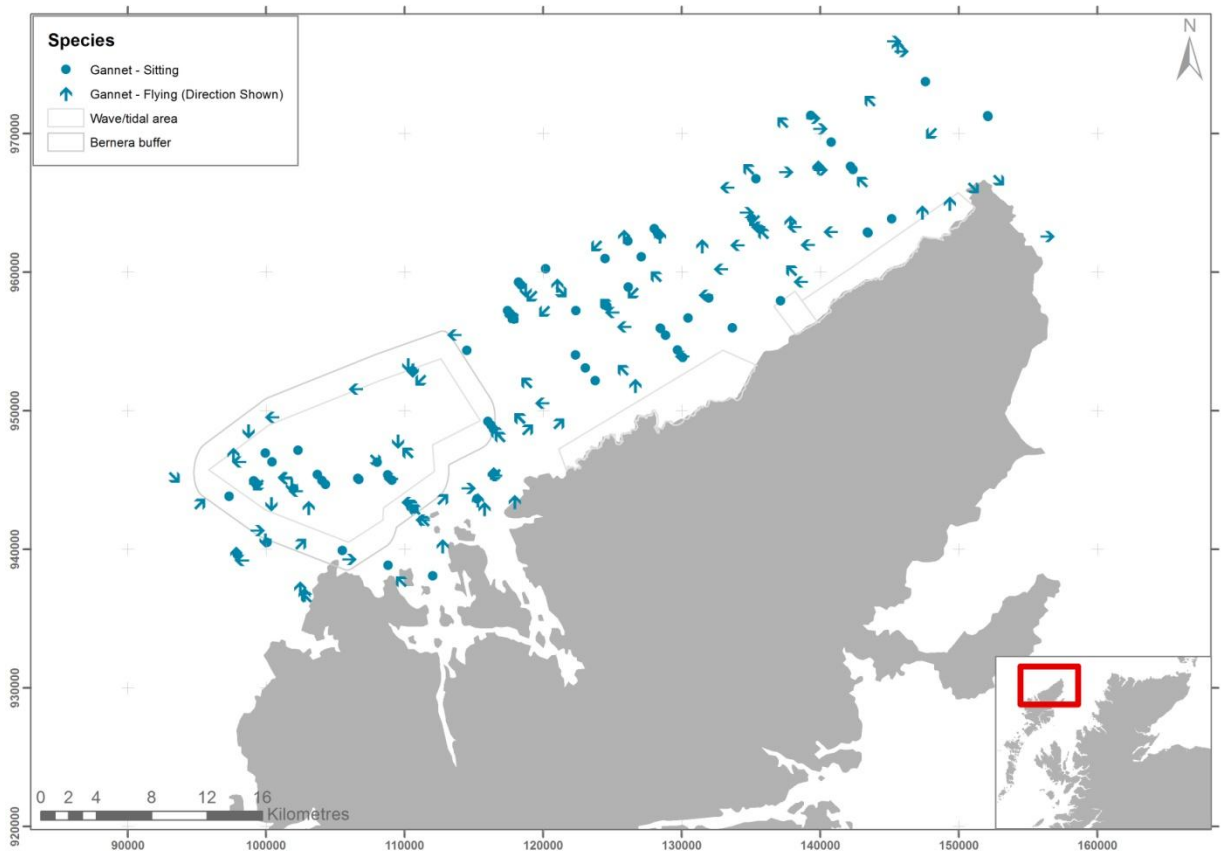


Figure 25 – July gull and skua records from digital aerial survey

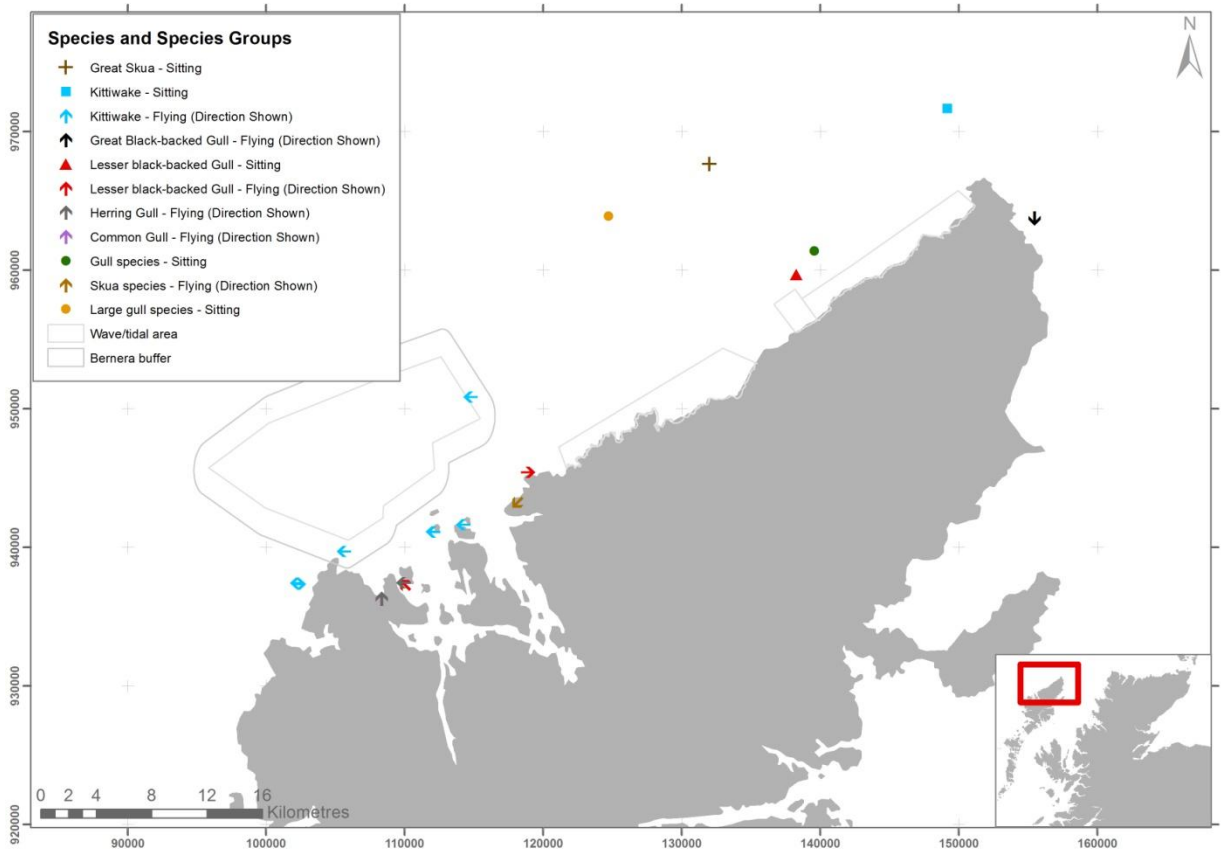


Figure 26 – July auk records from digital aerial survey

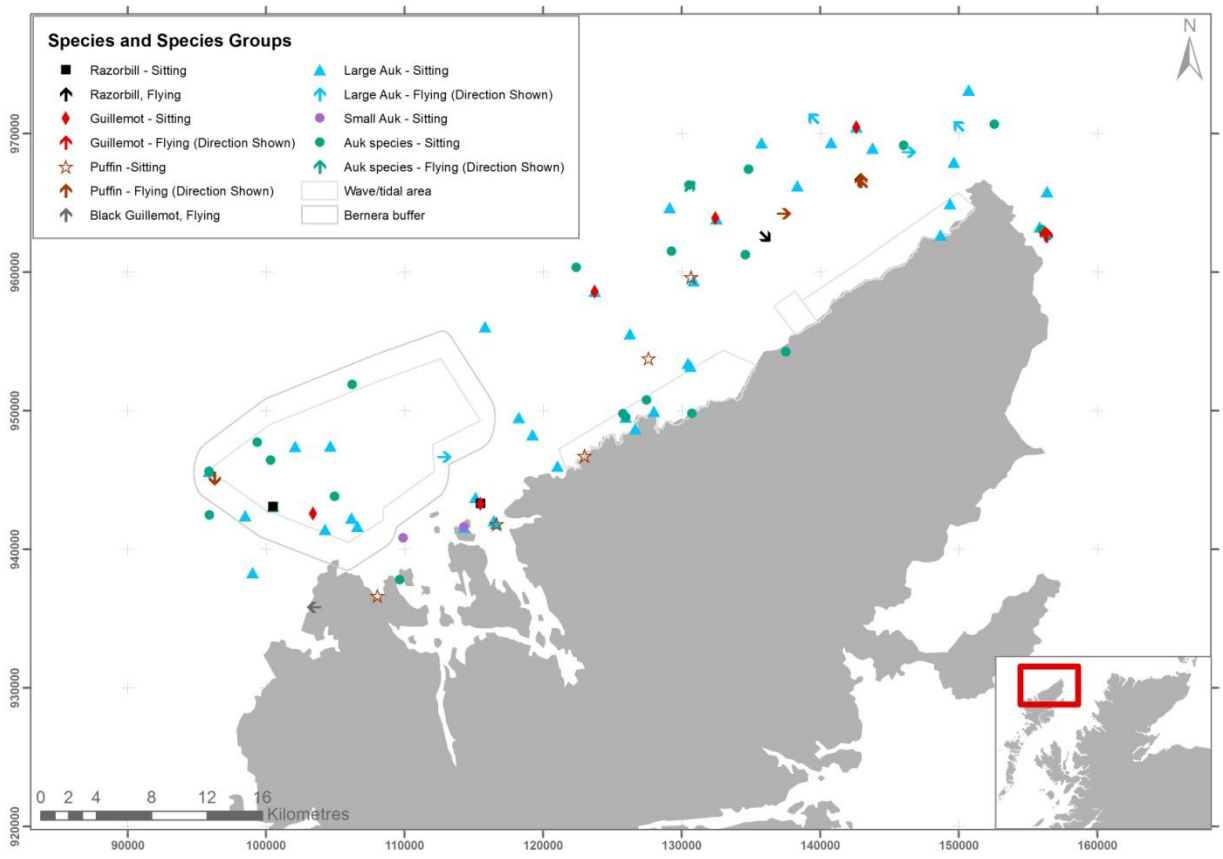


Figure 27 – July cetacean, marine mammal and shark records from digital aerial survey

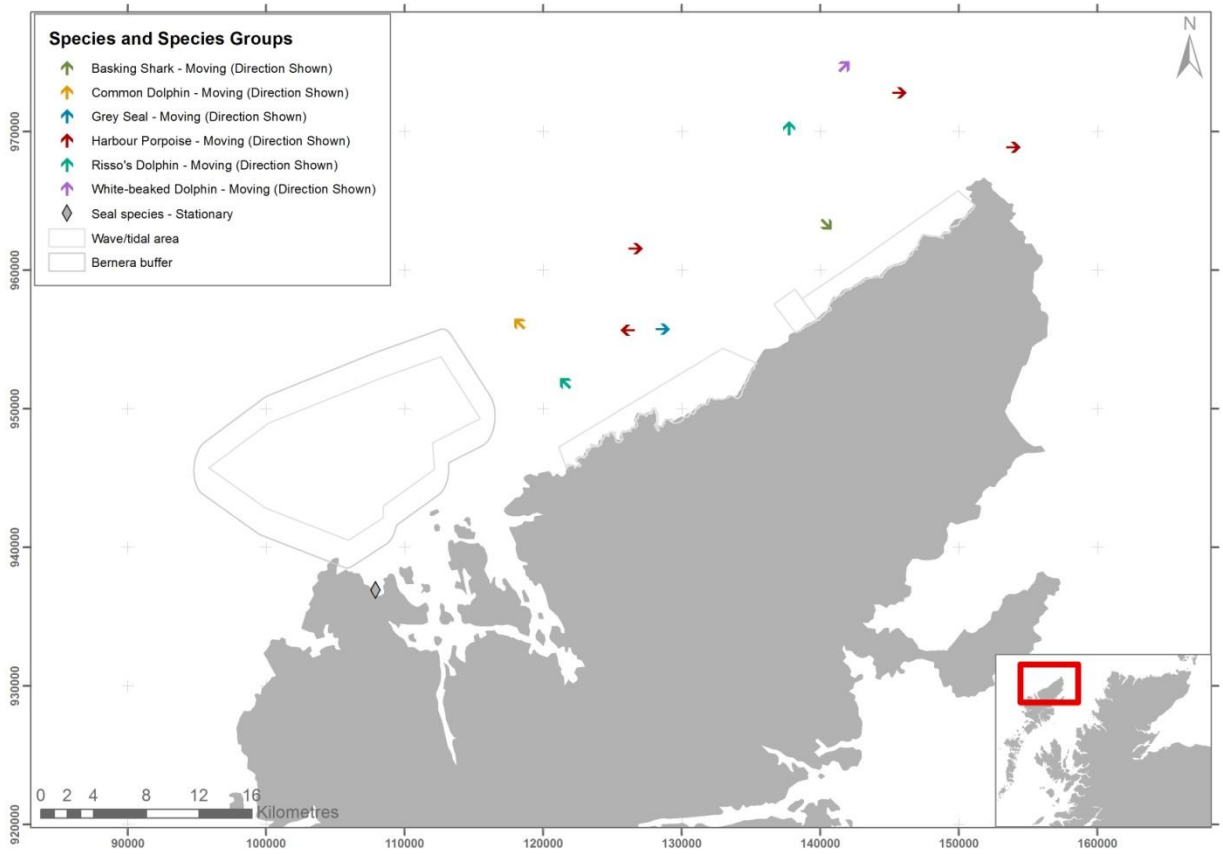


Figure 28 – September diver and cormorant records from digital aerial survey

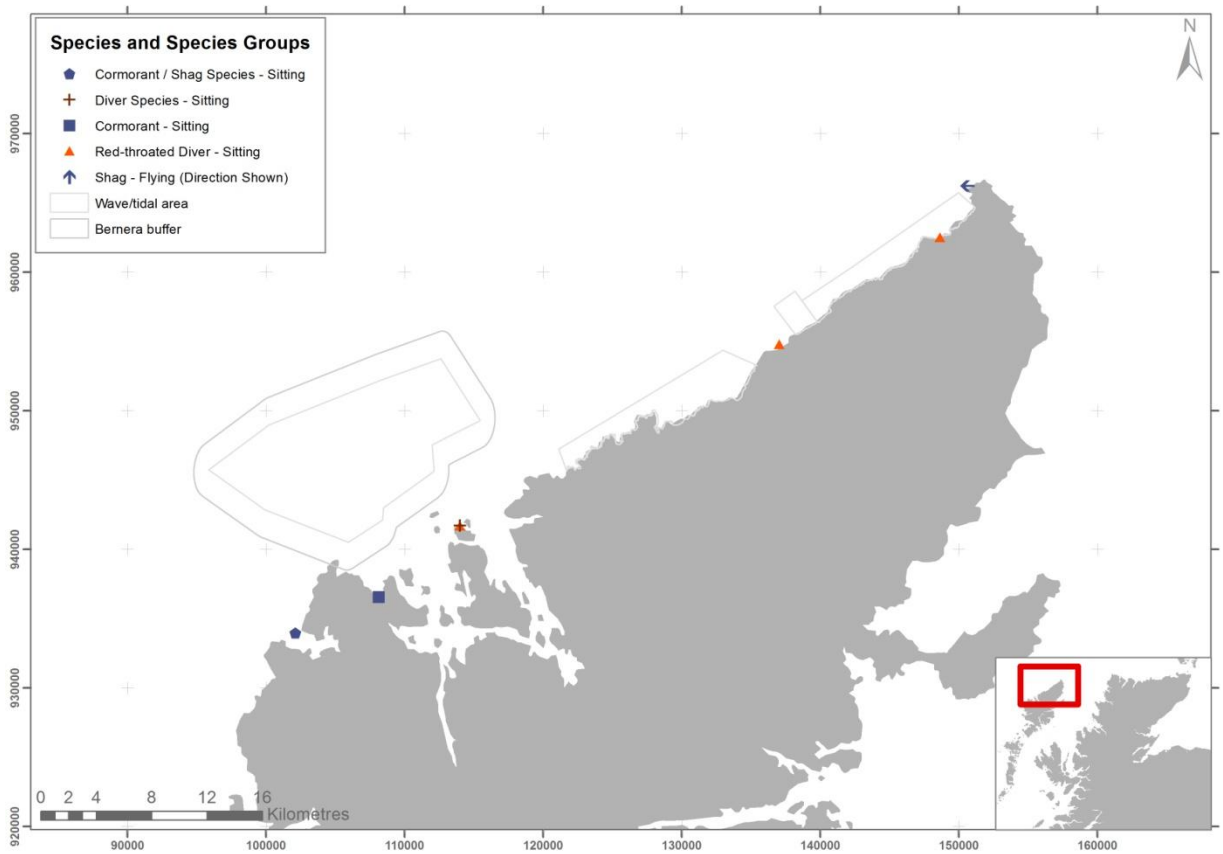


Figure 29 – September fulmar records from digital aerial survey

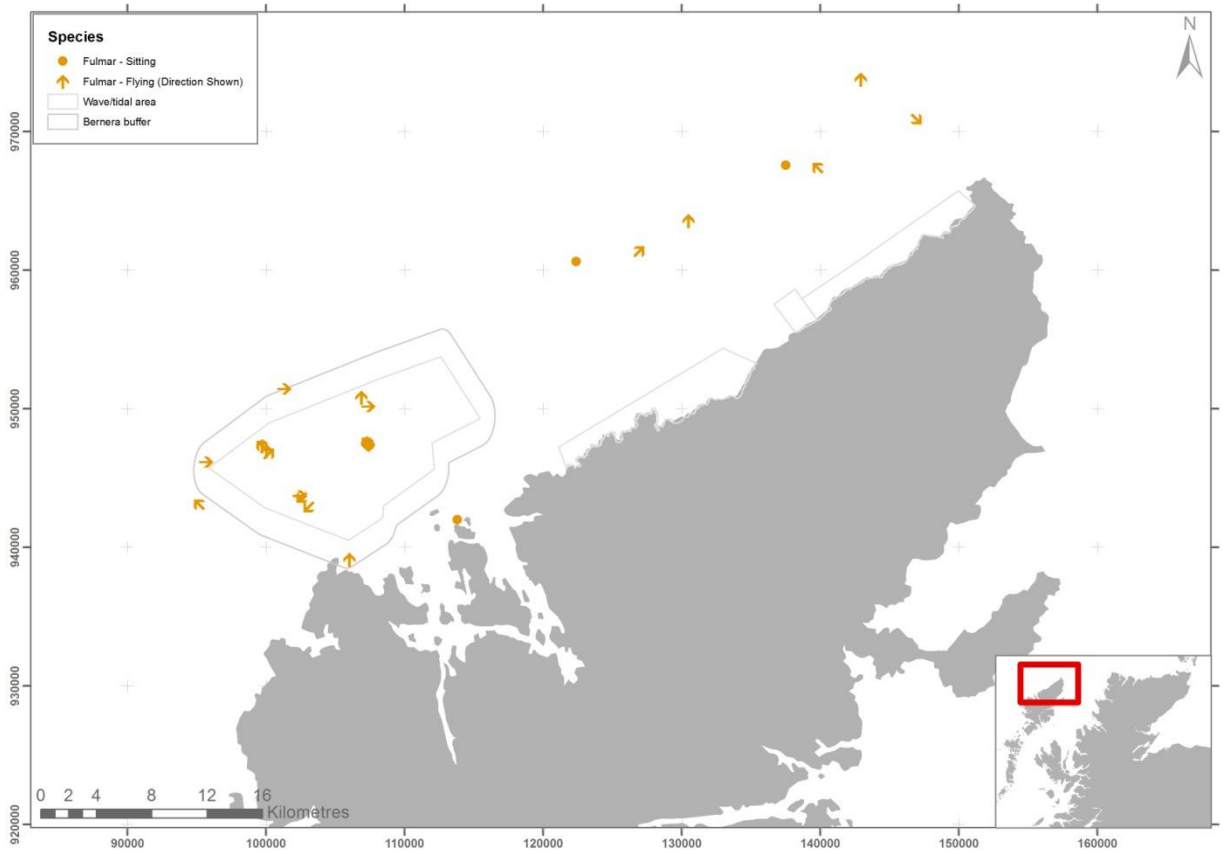


Figure 30 - September gannet records from digital aerial survey

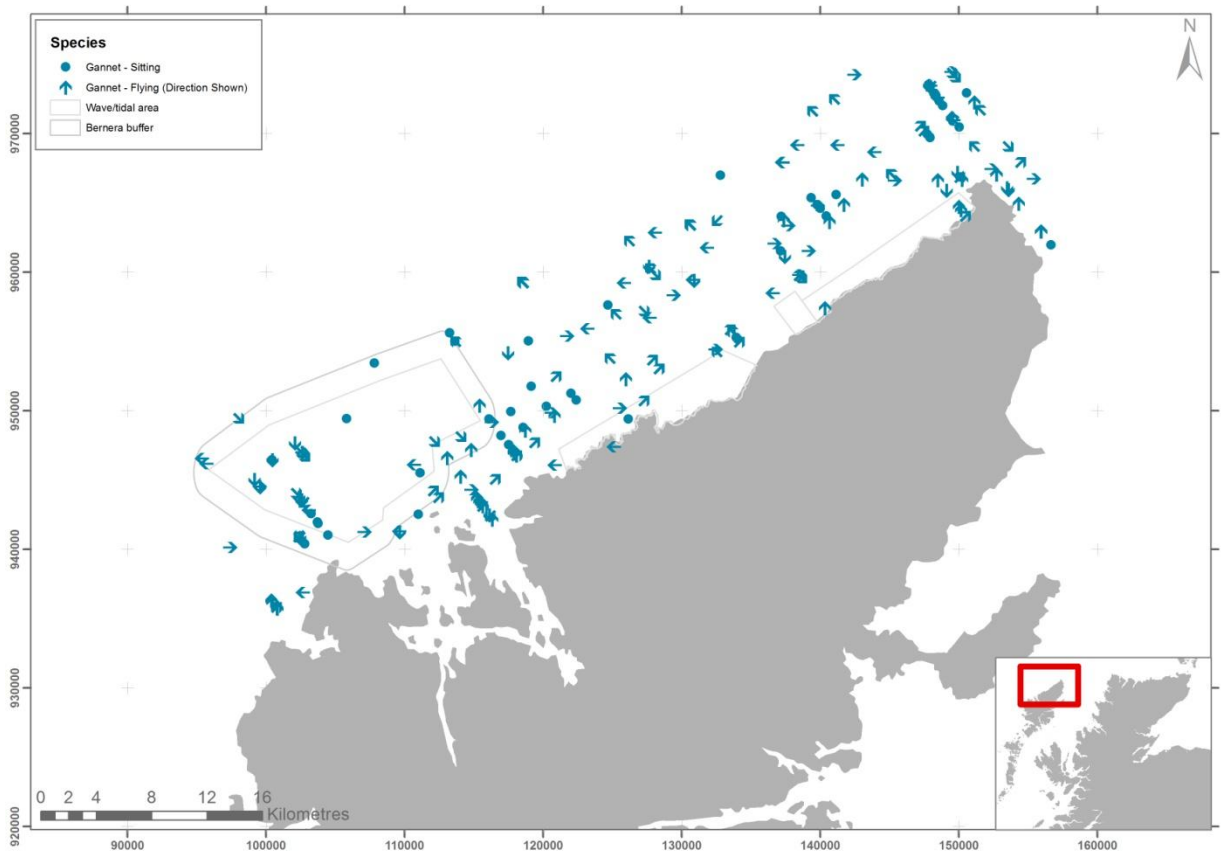


Figure 31 – September gull records from digital aerial survey

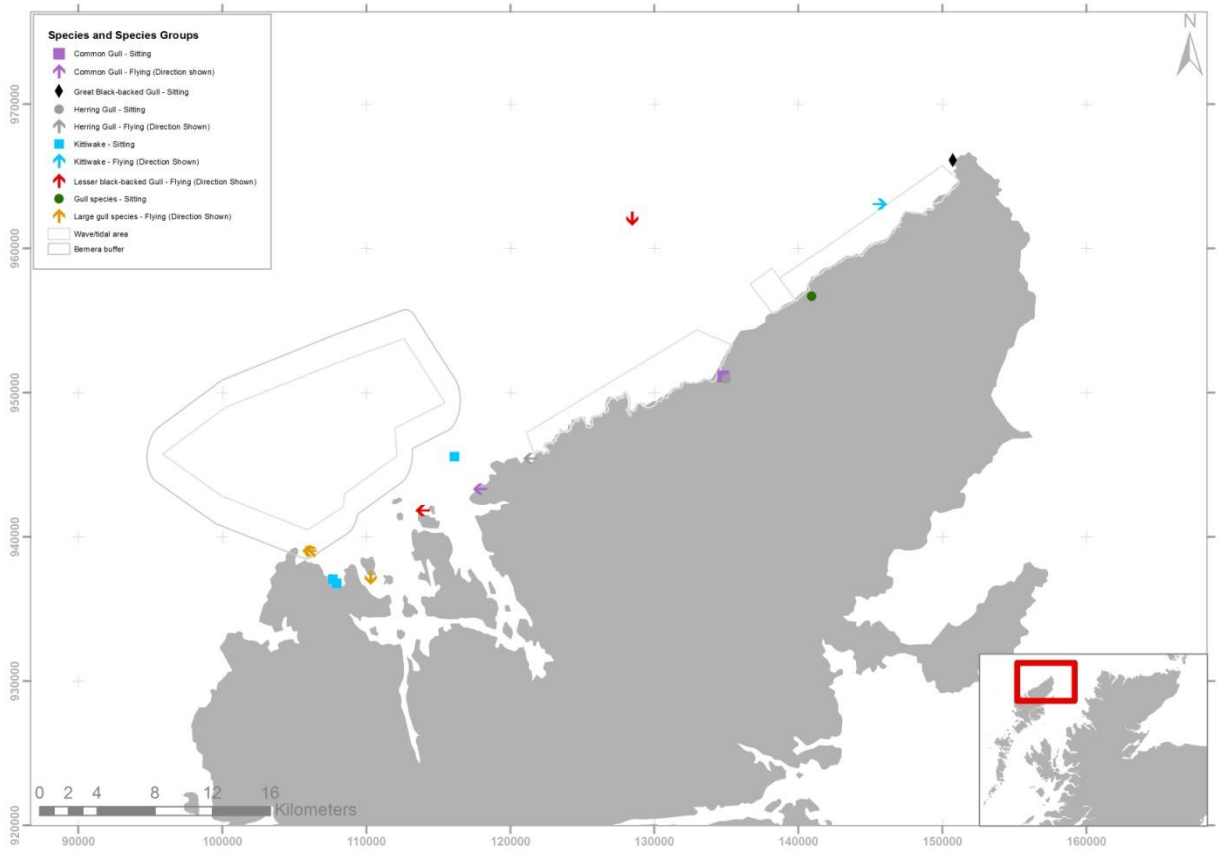


Figure 32 - September auk records from digital aerial survey

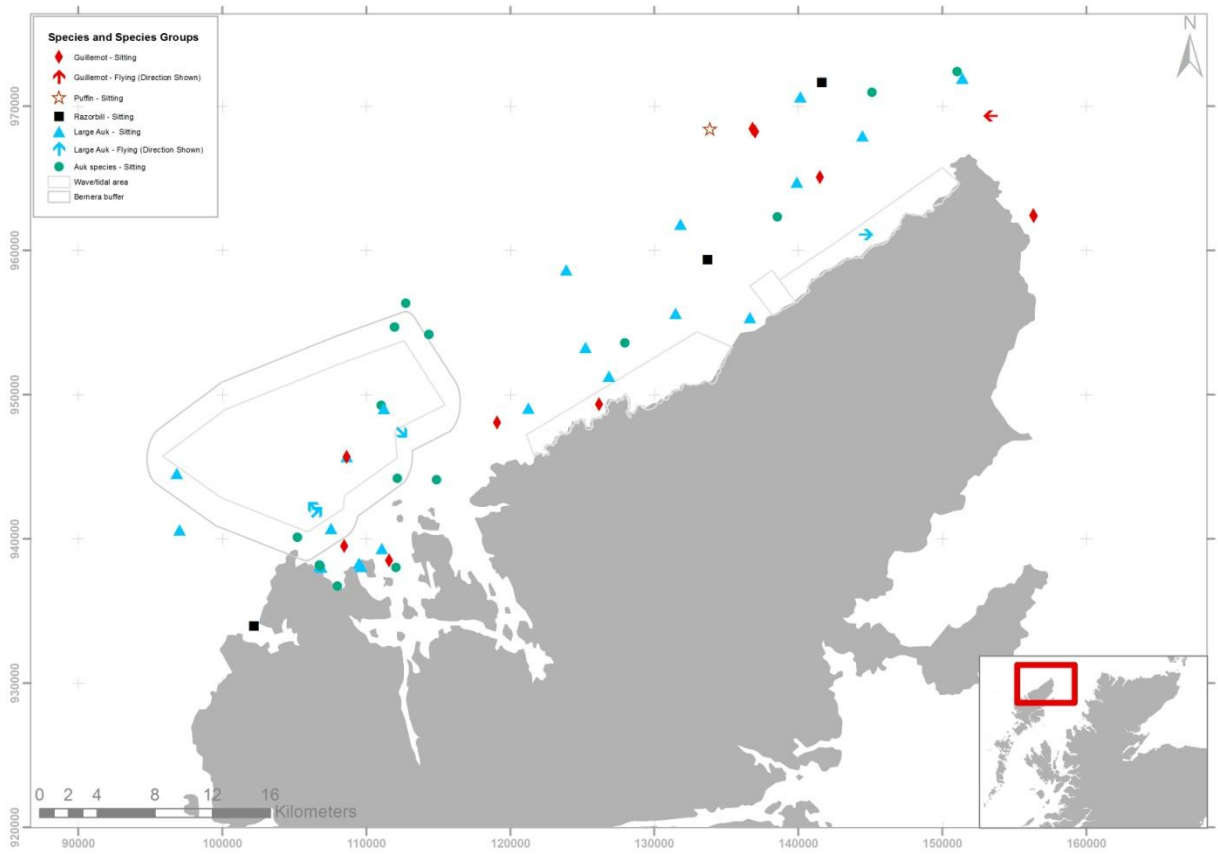


Figure 33 - September cetacean, seal and shark records from digital aerial survey

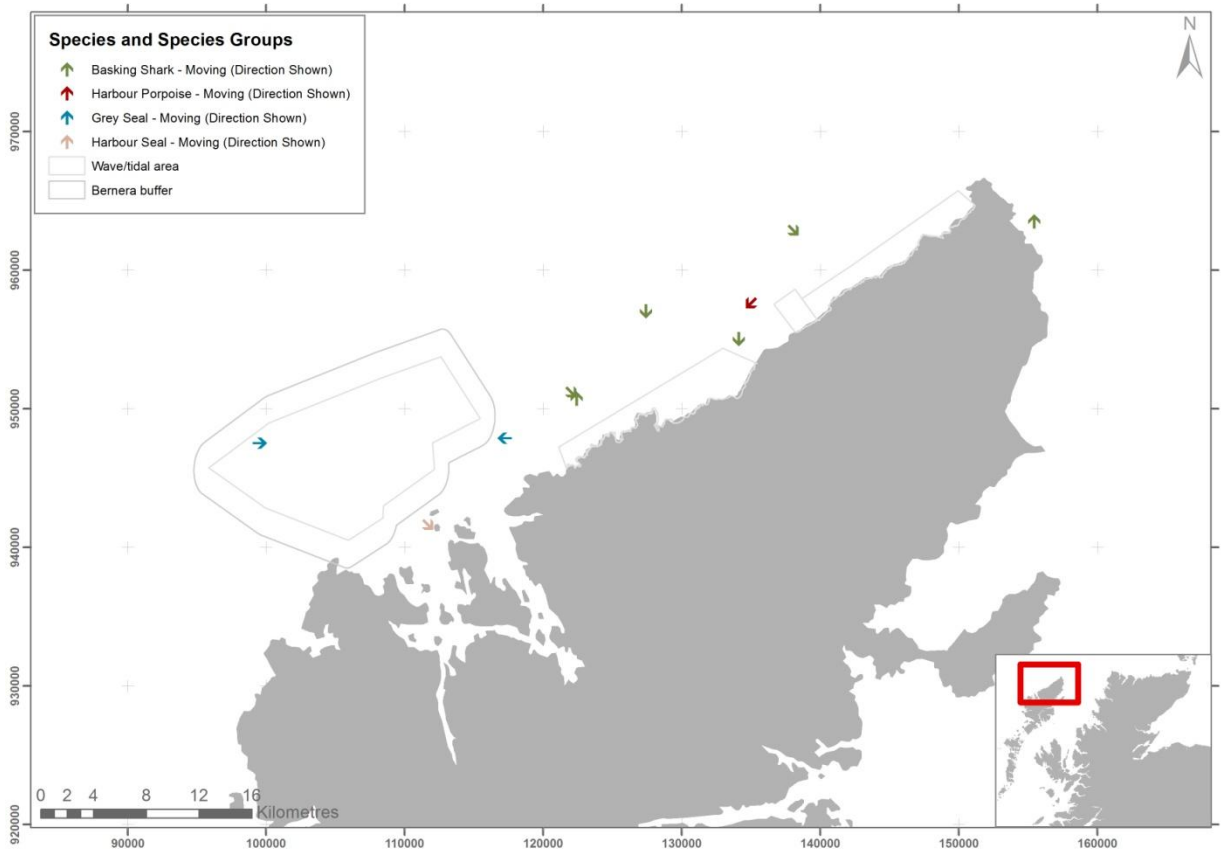


Figure 34 – December duck and diver records from digital aerial survey

Figure 35 - December fulmar records from digital aerial survey

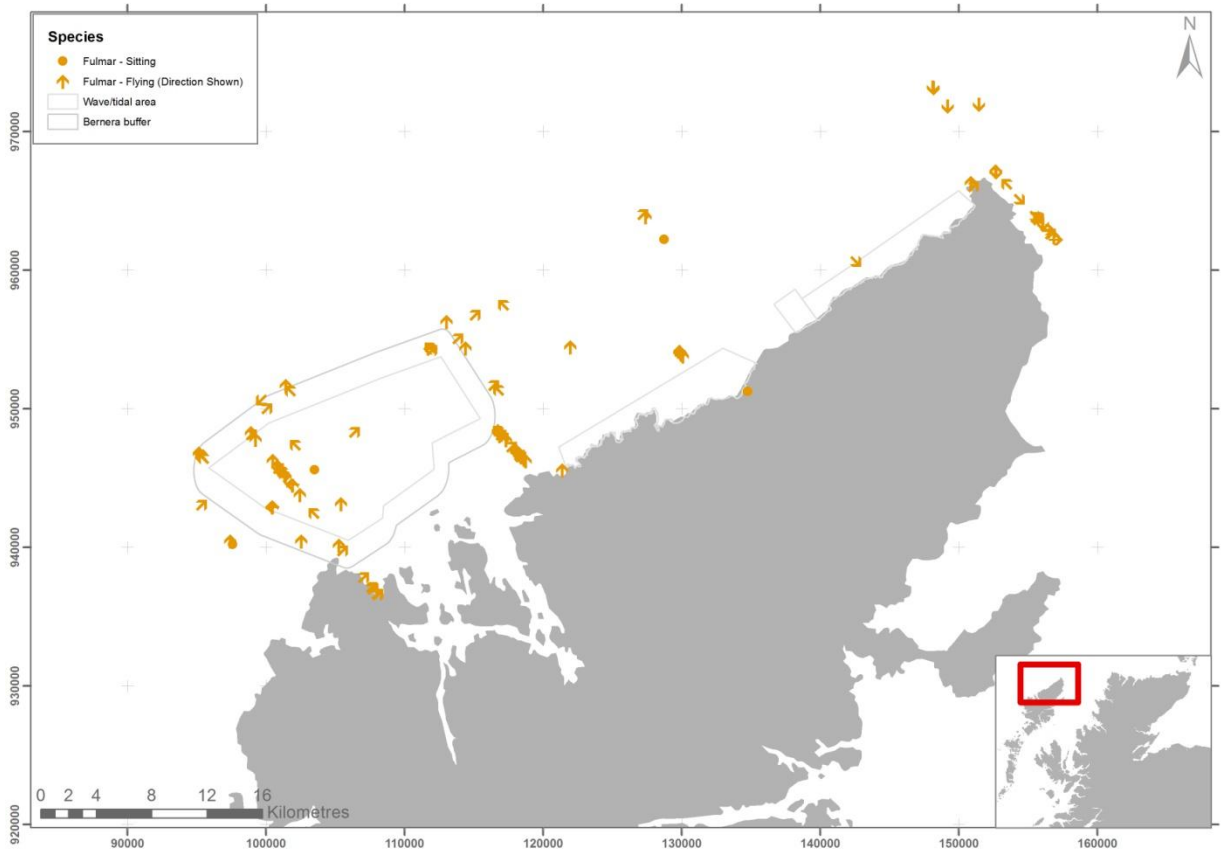


Figure 36 - December gannet records from digital aerial survey

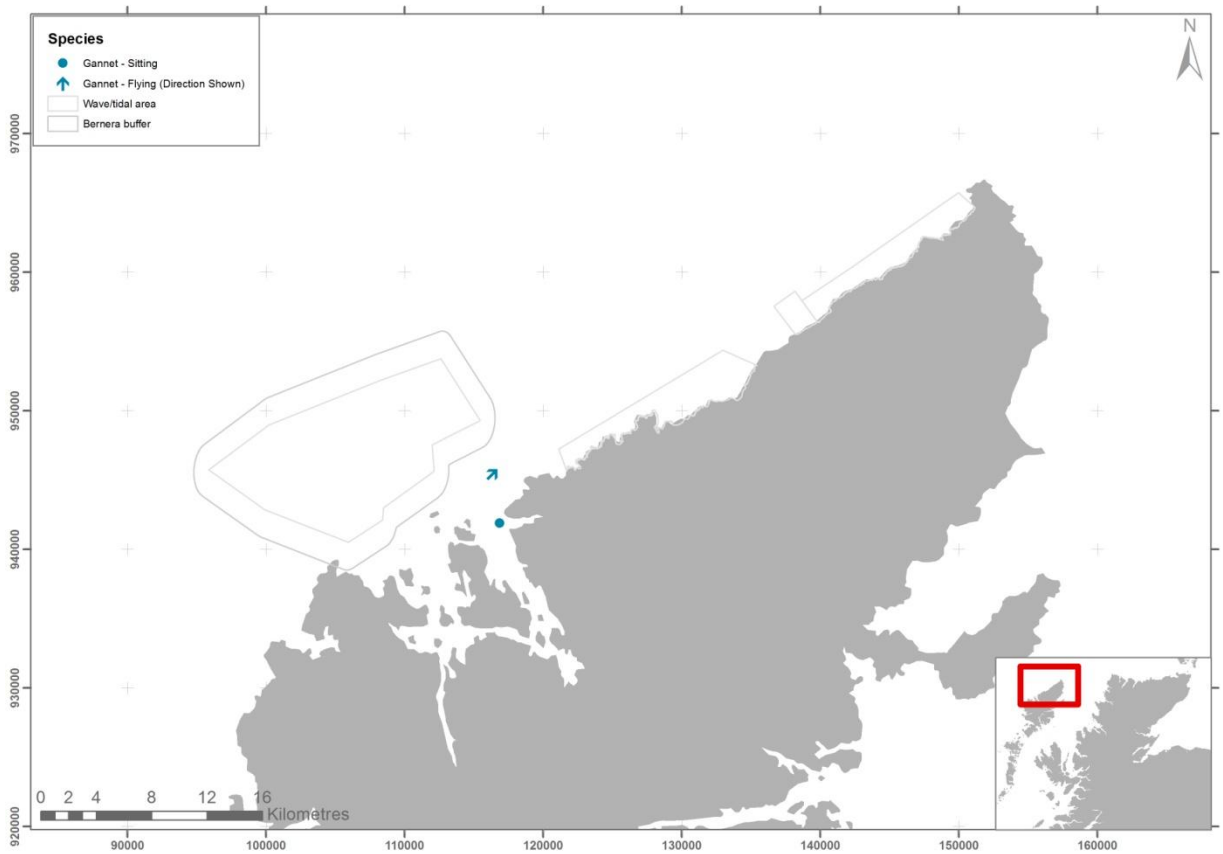


Figure 37 - December gull species records from digital aerial survey

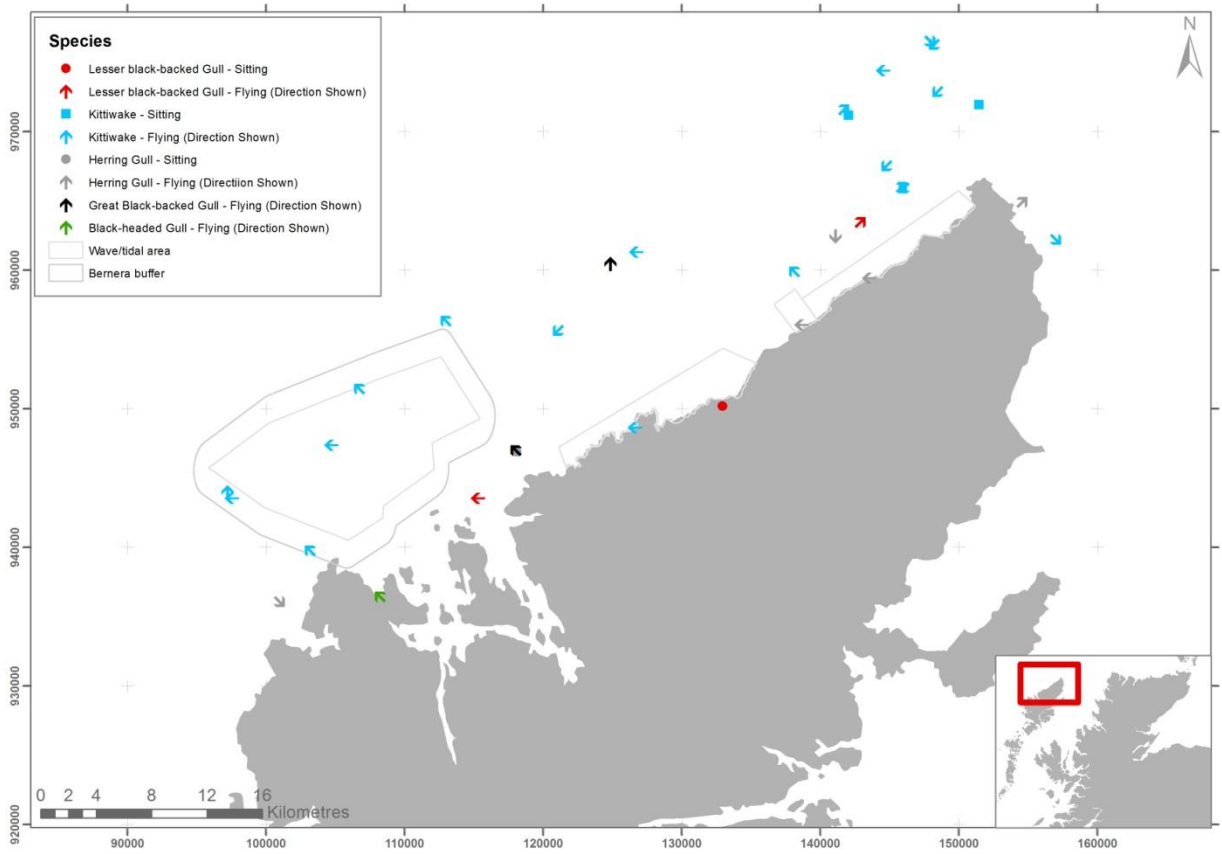


Figure 38 - December gull species group records from digital aerial survey

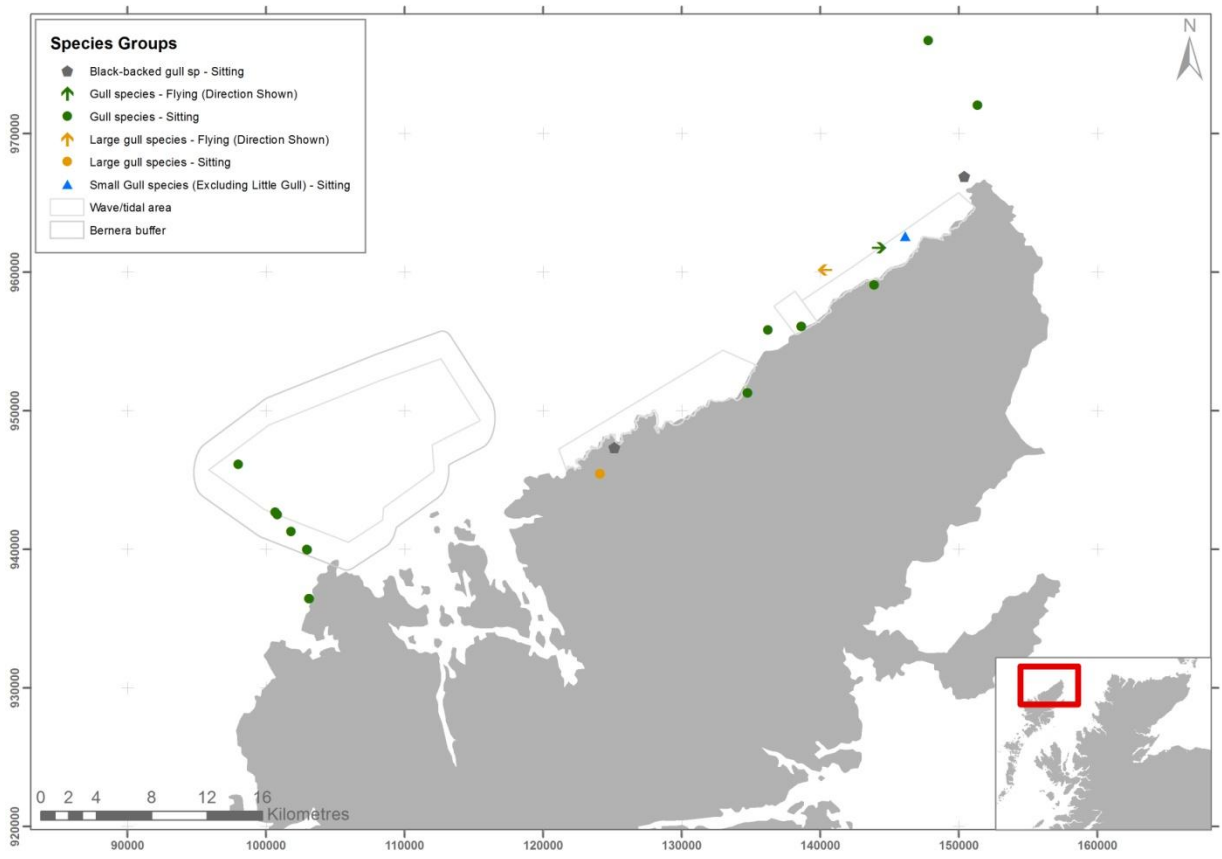


Figure 39 - December auk records from digital aerial survey

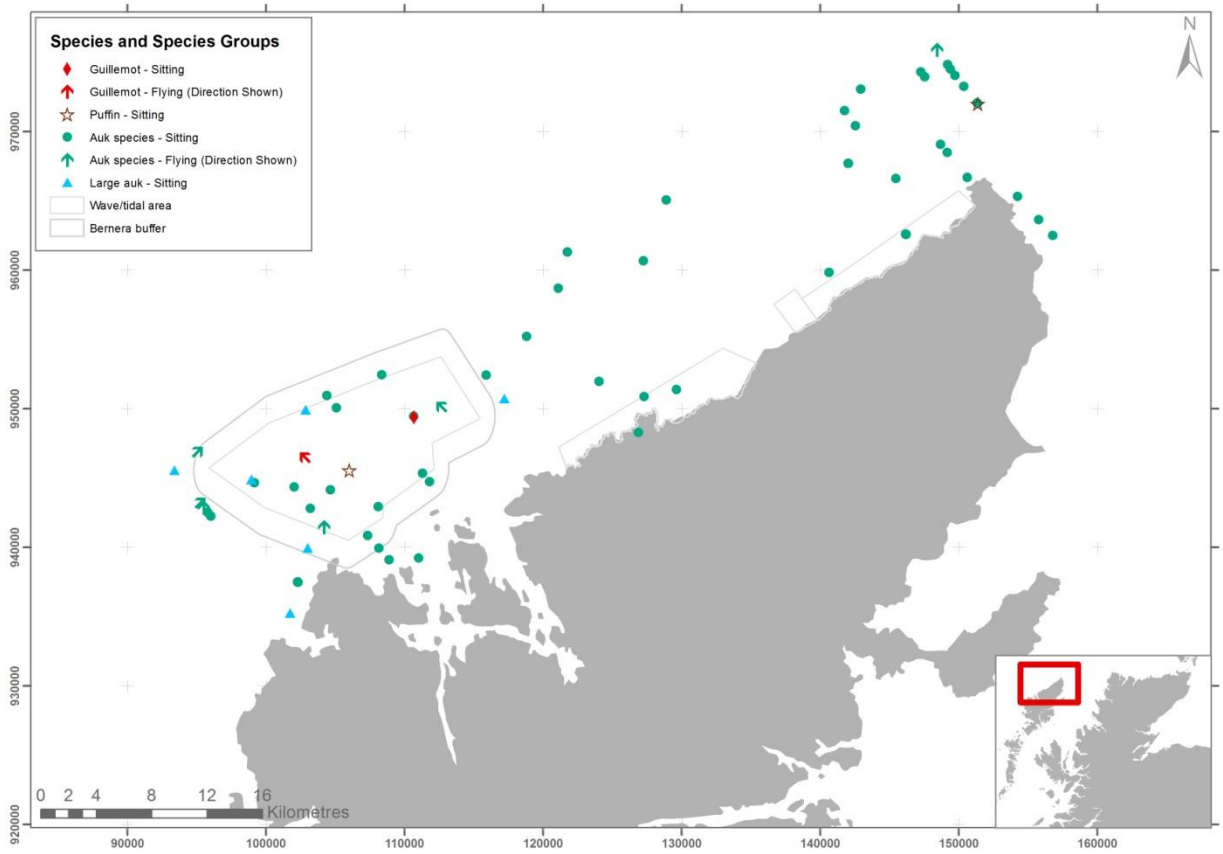


Figure 40 - December cetacean records from digital aerial survey

Figure 41 – February duck and diver records from digital aerial survey

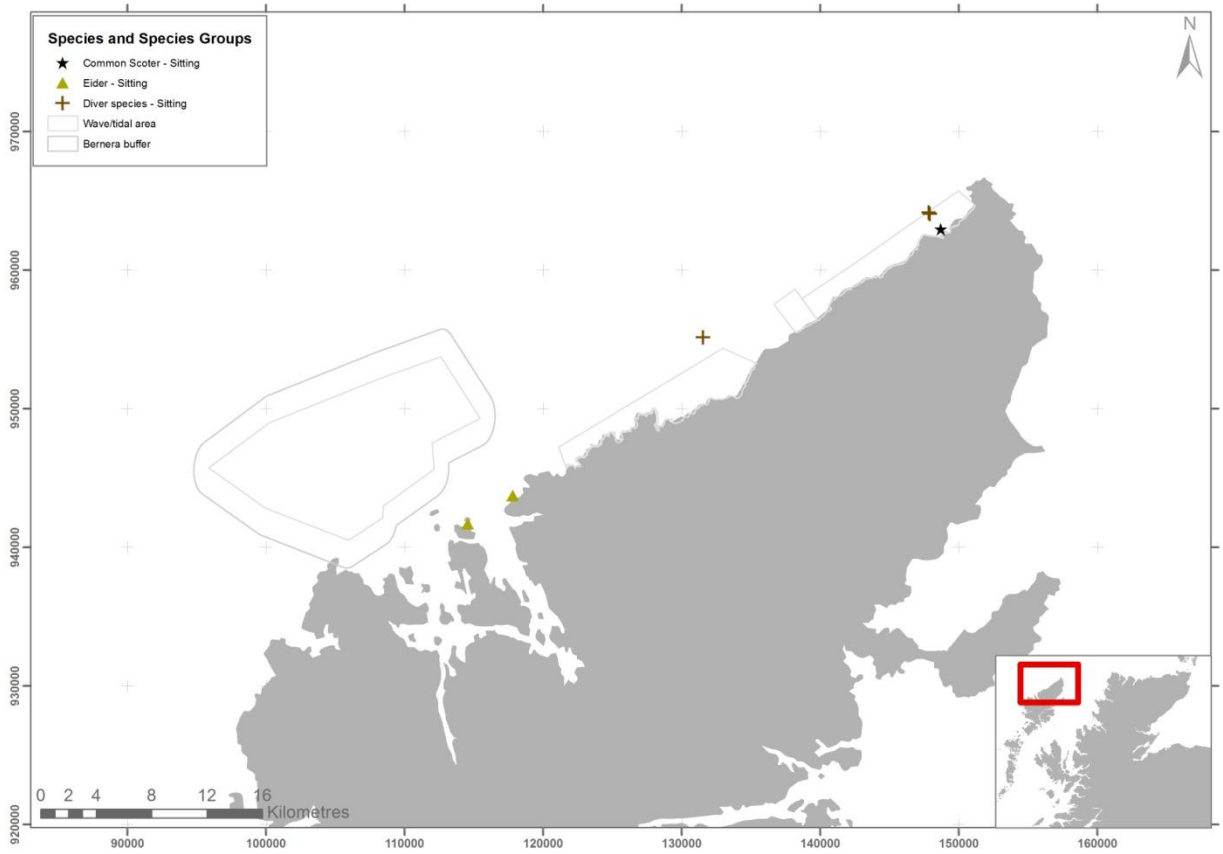


Figure 42 - February fulmar records from digital aerial survey

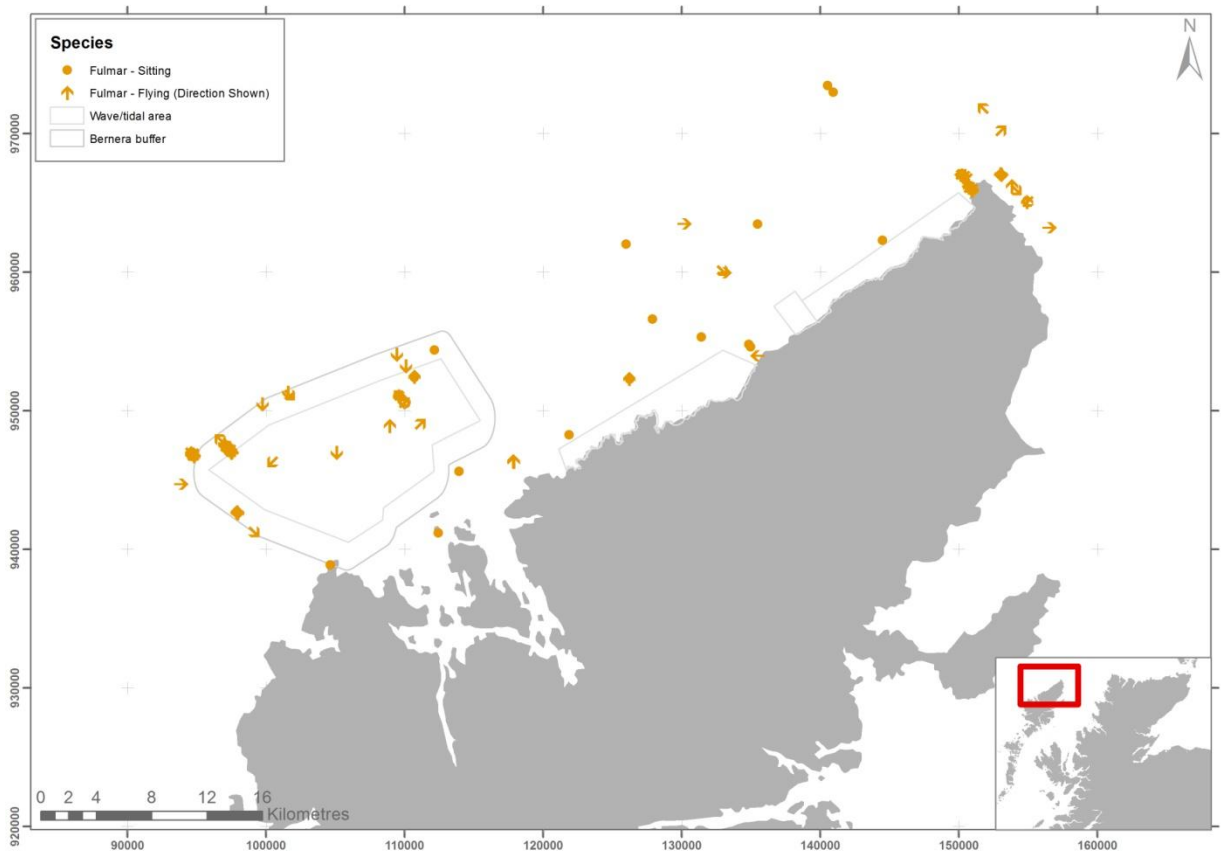


Figure 43 - February gannet records from digital aerial survey

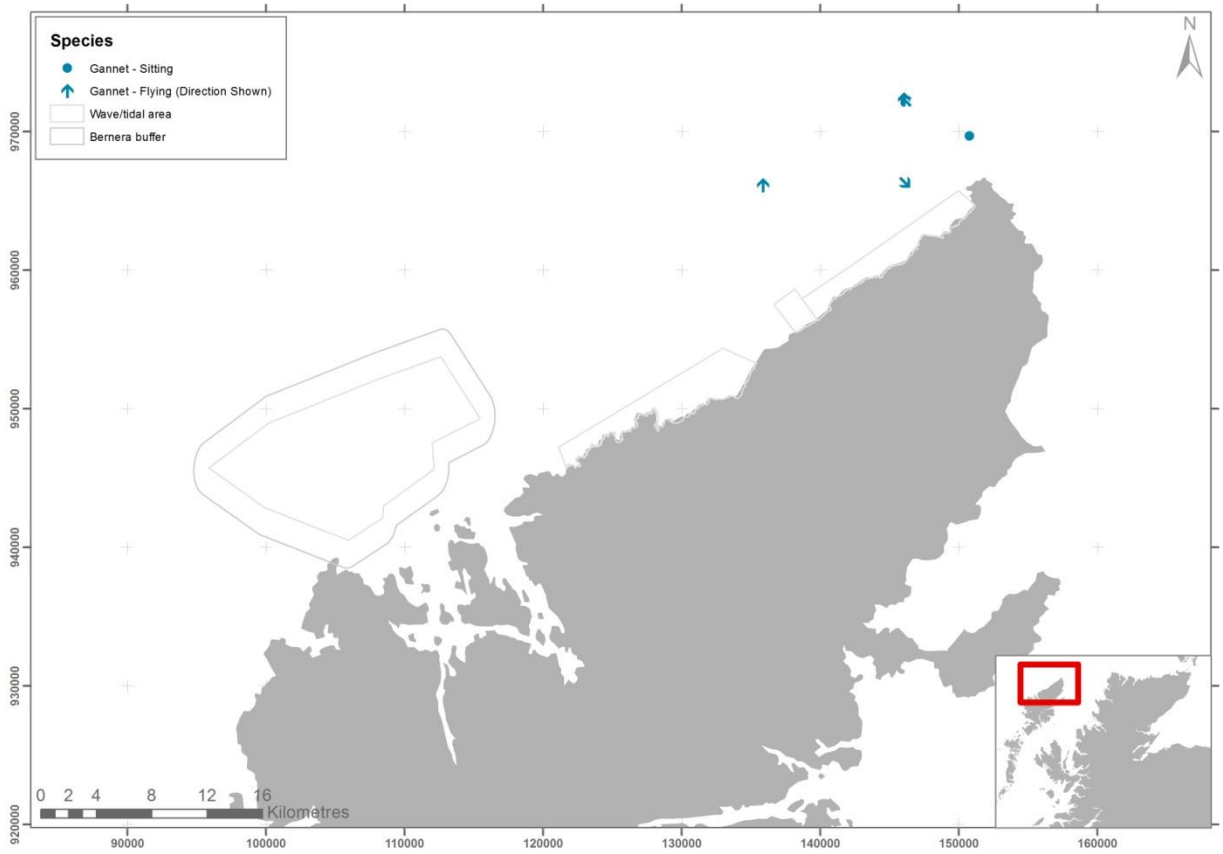


Figure 44 - February gull species records from digital aerial survey

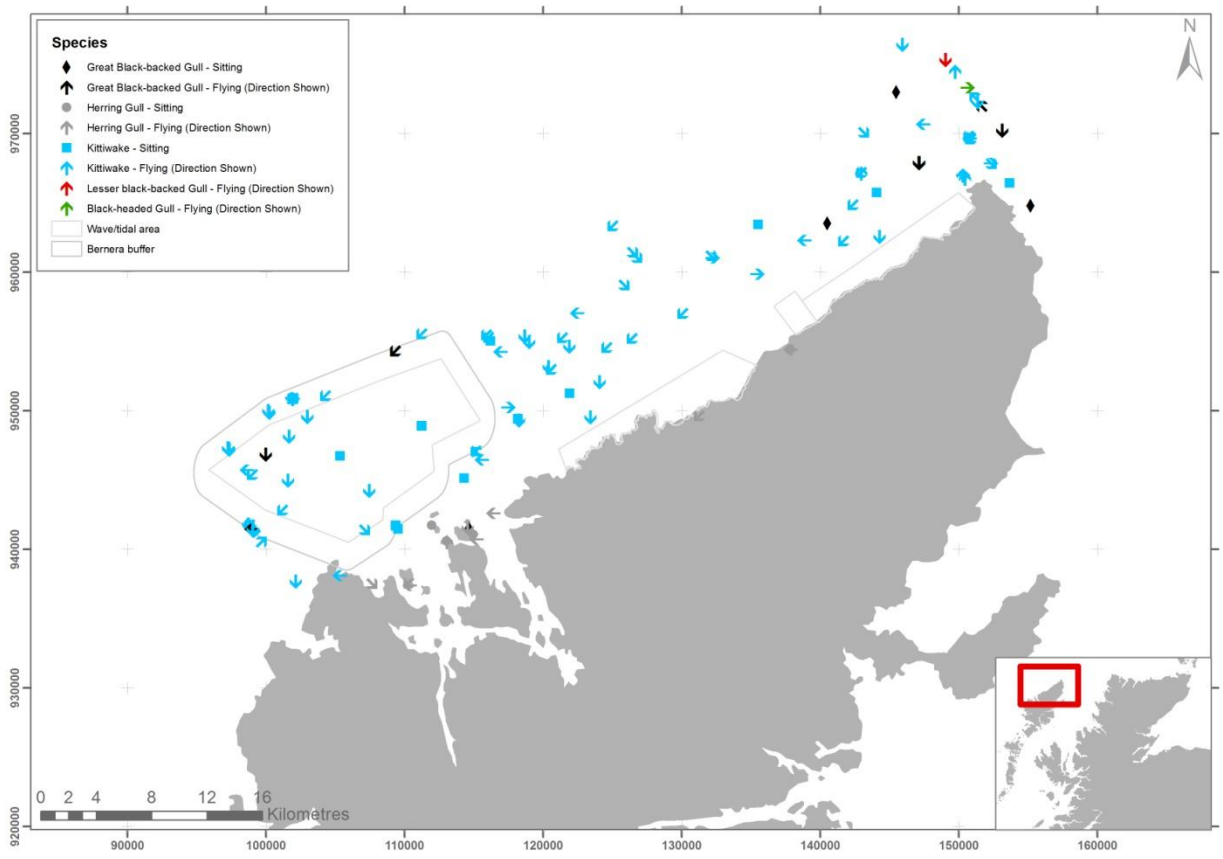


Figure 45 - February gull species group records from digital aerial survey

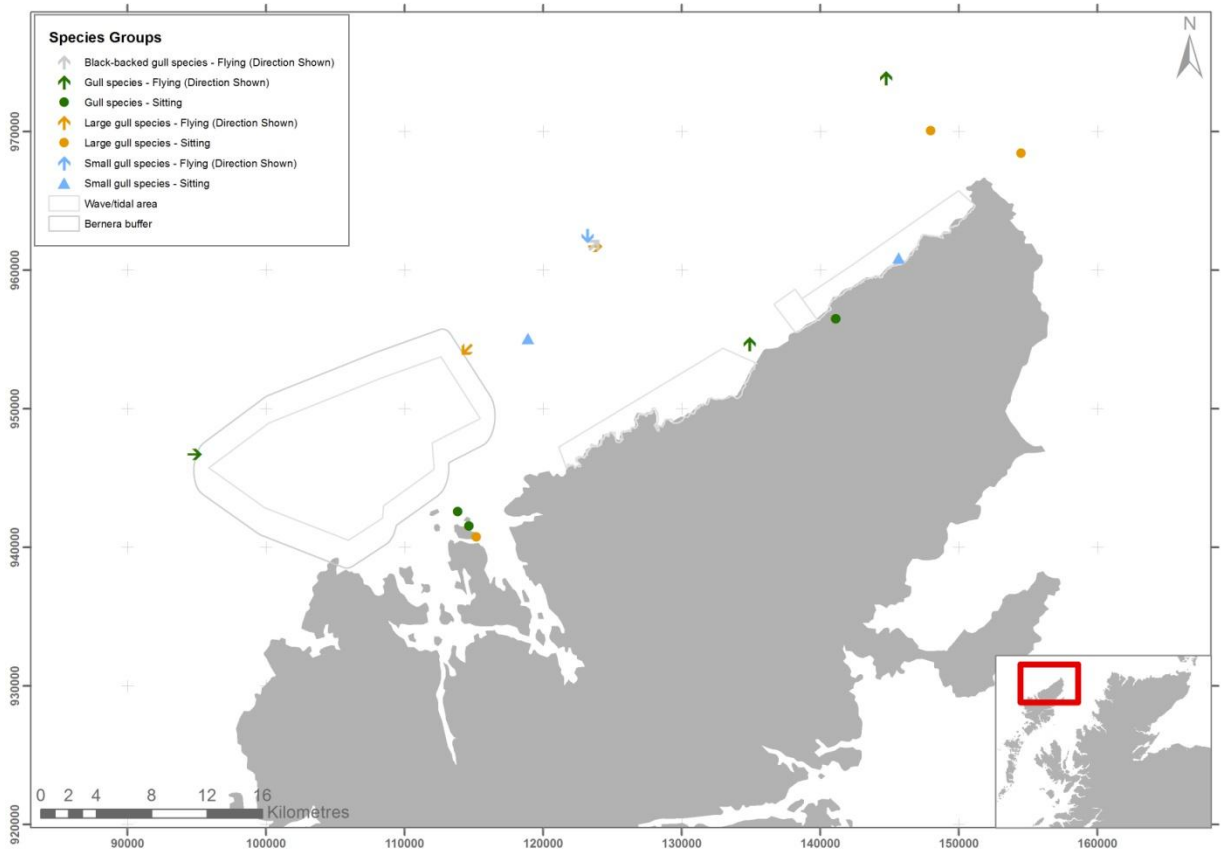


Figure 46 – February auk records from digital aerial survey

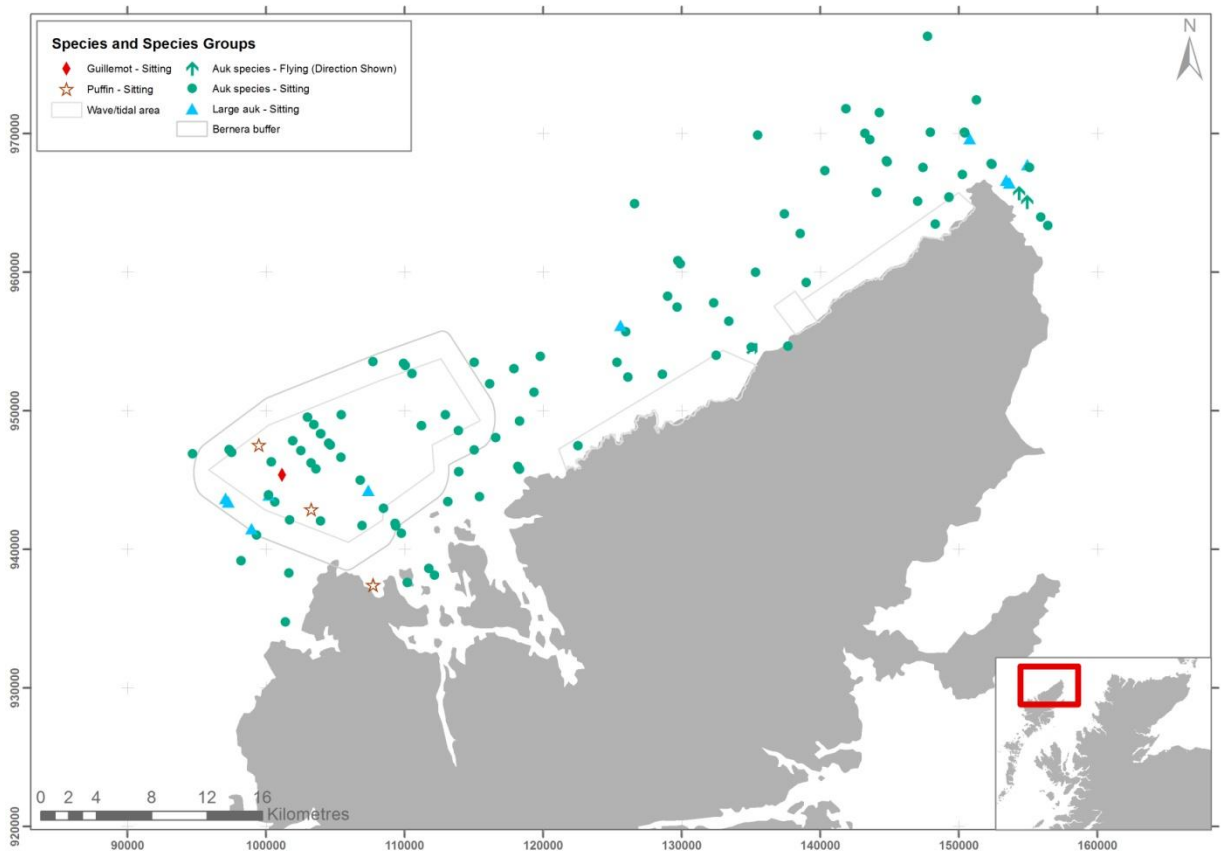


Figure 47 – February cetacean records from digital aerial survey

Figure 48 – April shag and diver records from ground-based counts

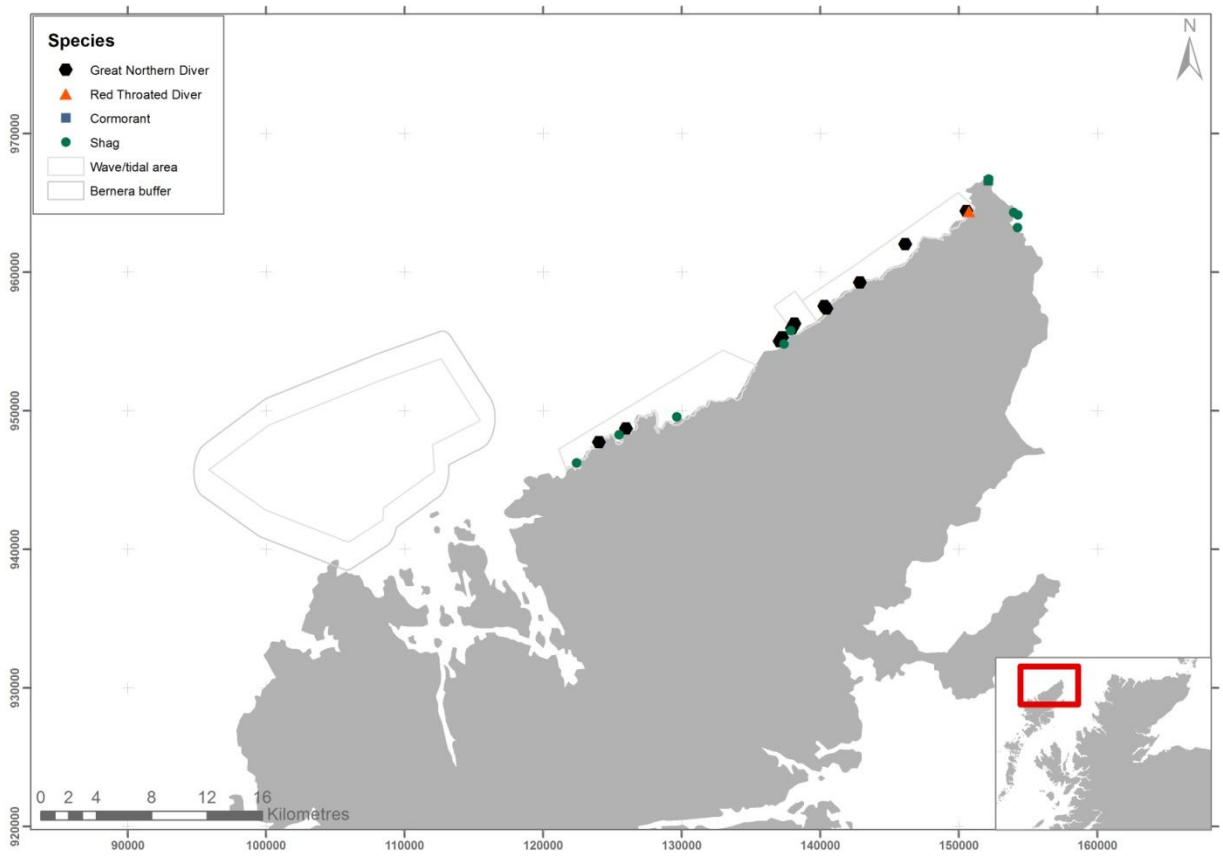


Figure 49 – April fulmar records from ground-based counts

Figure 50 – April gannet records from ground-based counts

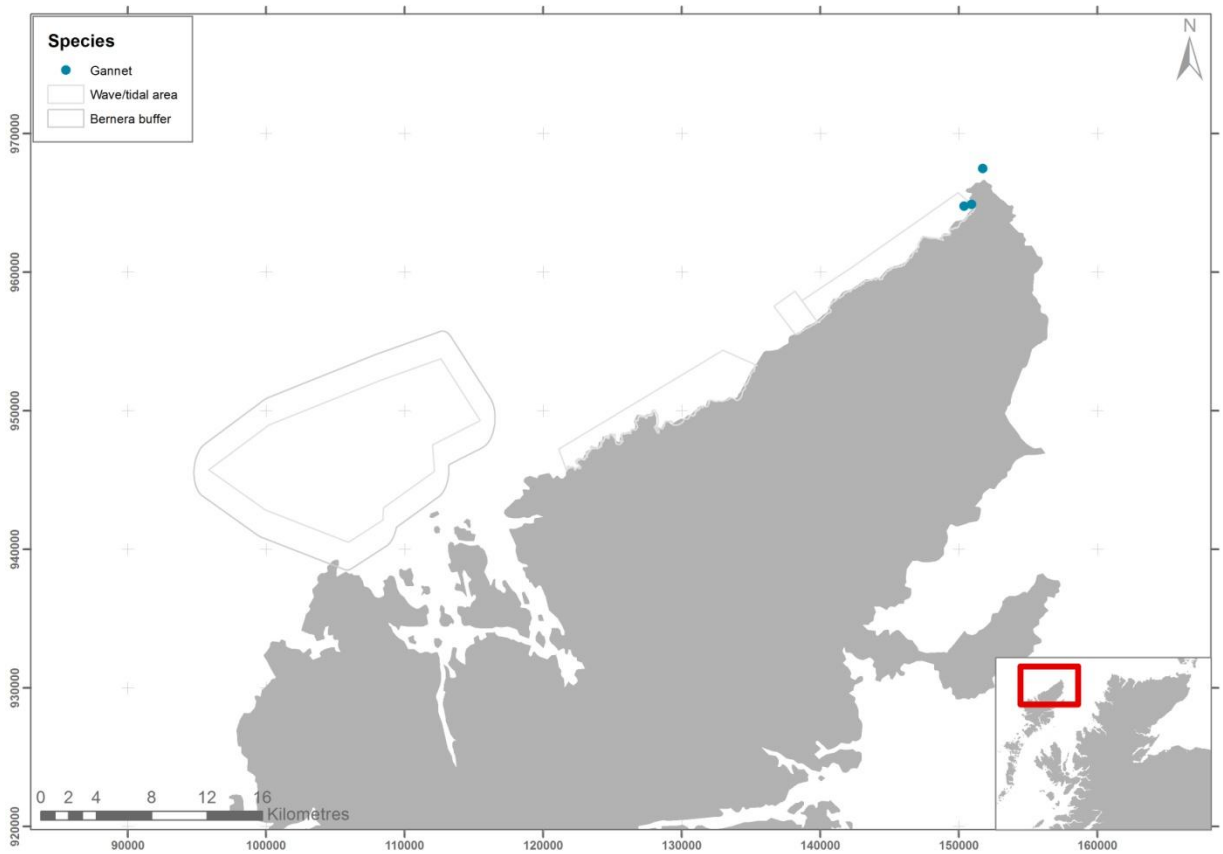


Figure 51 – April gull and skua records from ground-based counts

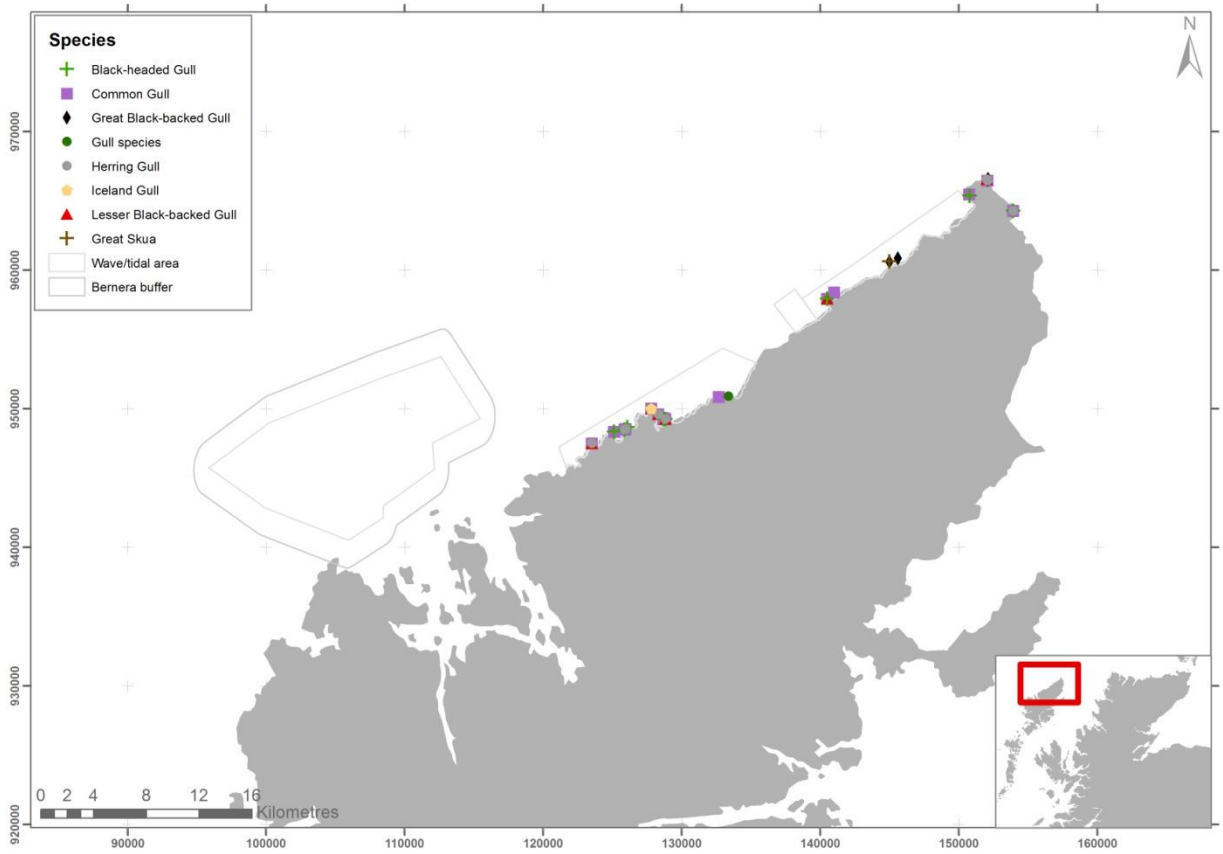


Figure 52 – April auk records from ground-based counts

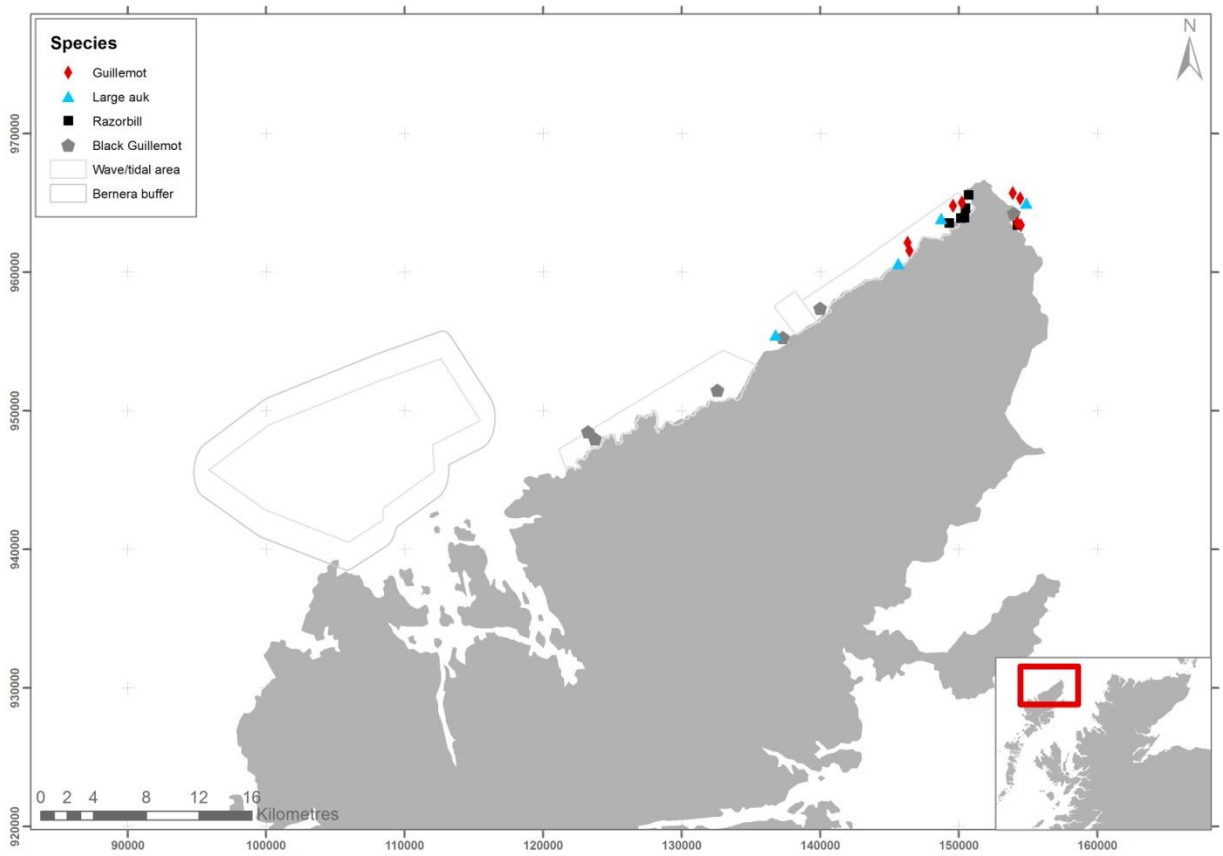


Figure 53 – May diver and shag records from ground-based counts

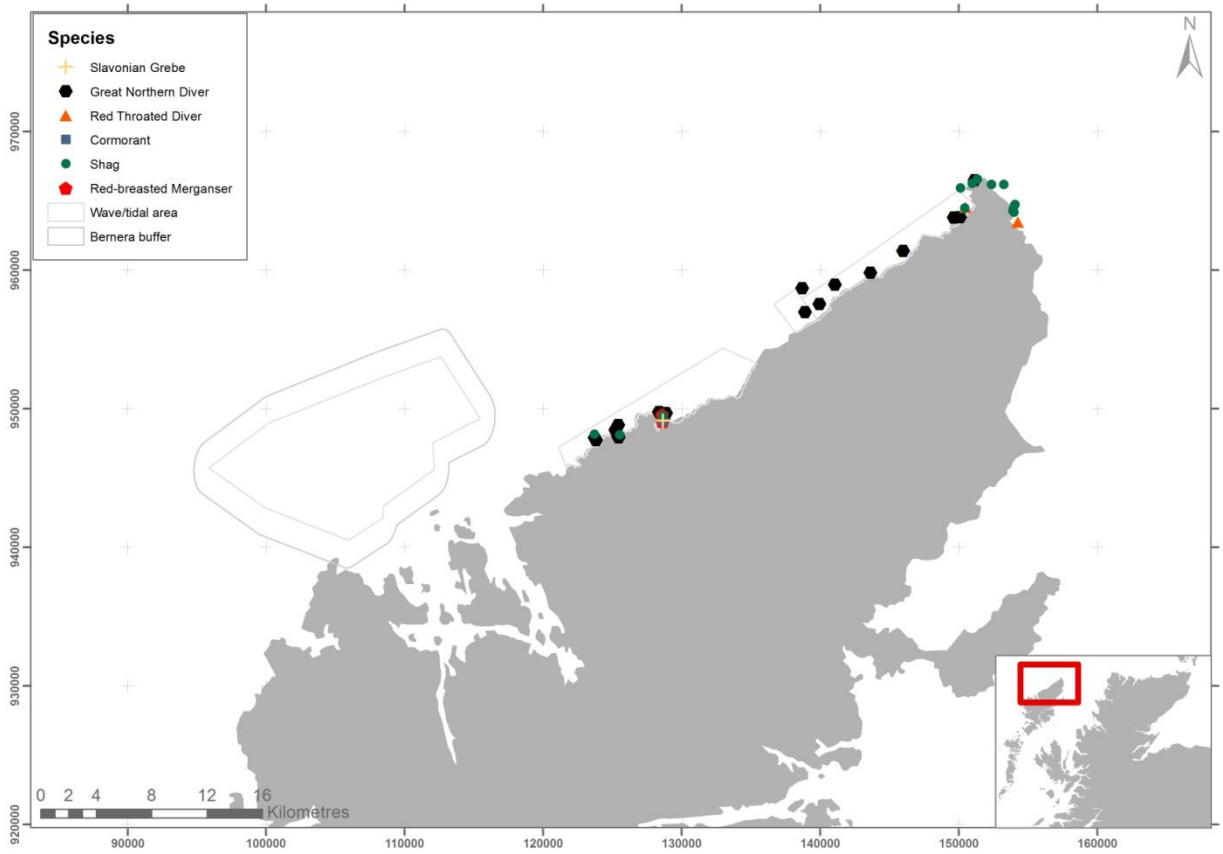


Figure 54 – May fulmar records from ground-based counts

Figure 55 – May gannet records from ground-based counts

Figure 56 – May gull records from ground-based counts

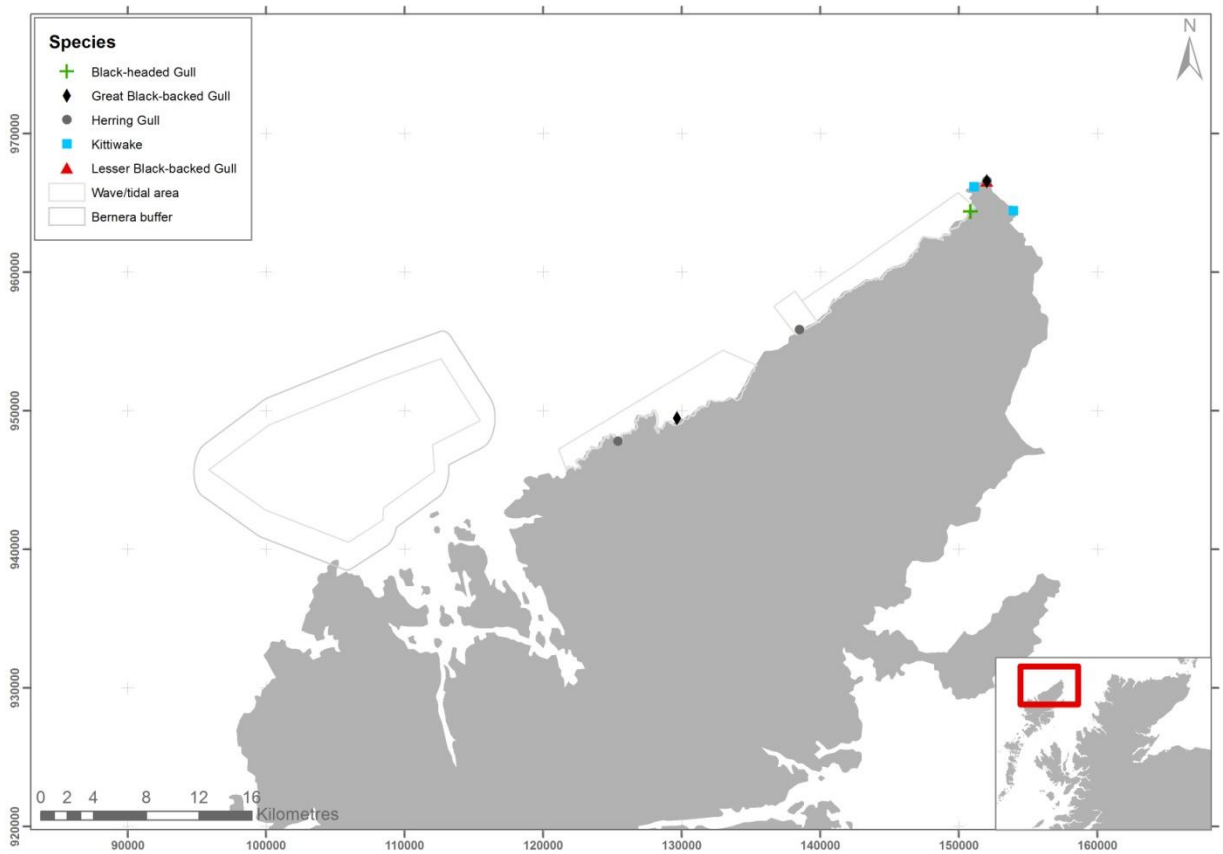


Figure 57 – May auk records from ground-based counts

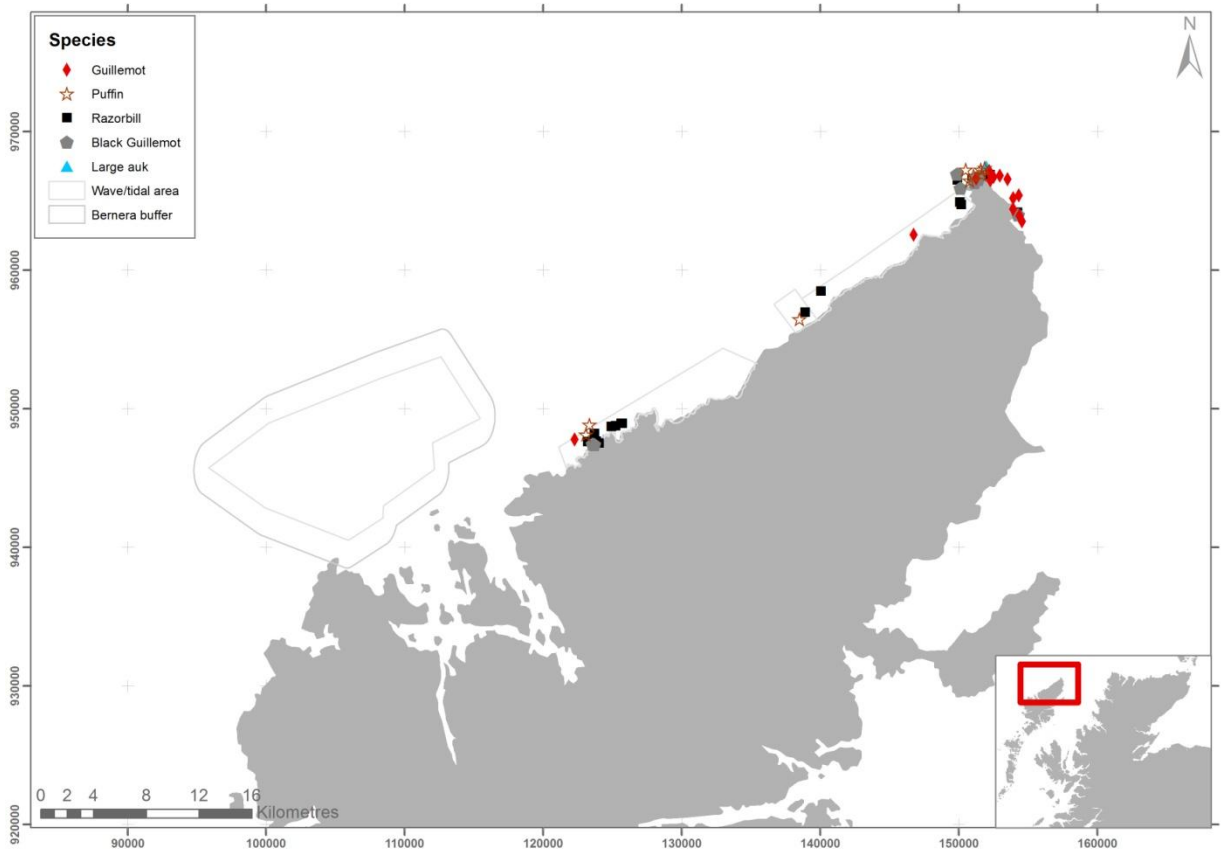


Figure 58 – June diver and shag records from ground-based counts

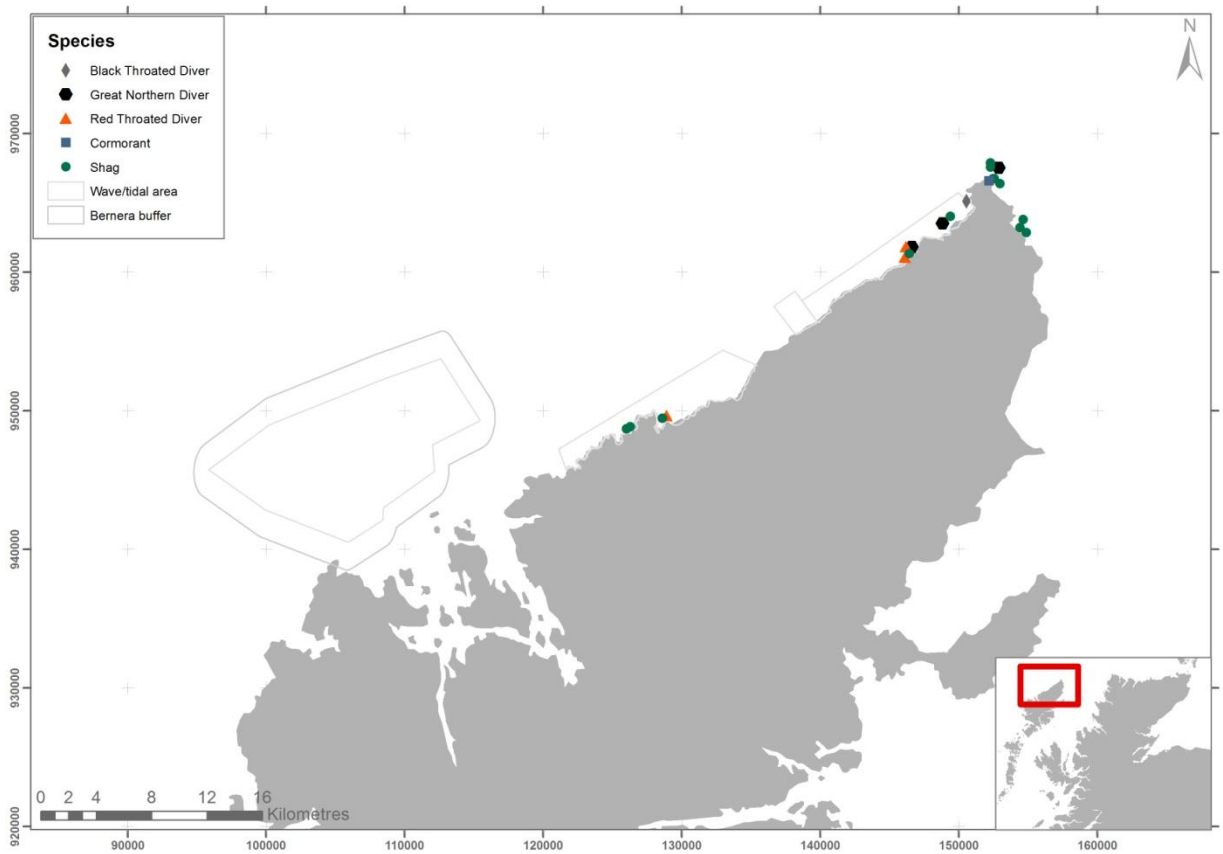


Figure 59 – June fulmar records from ground-based counts

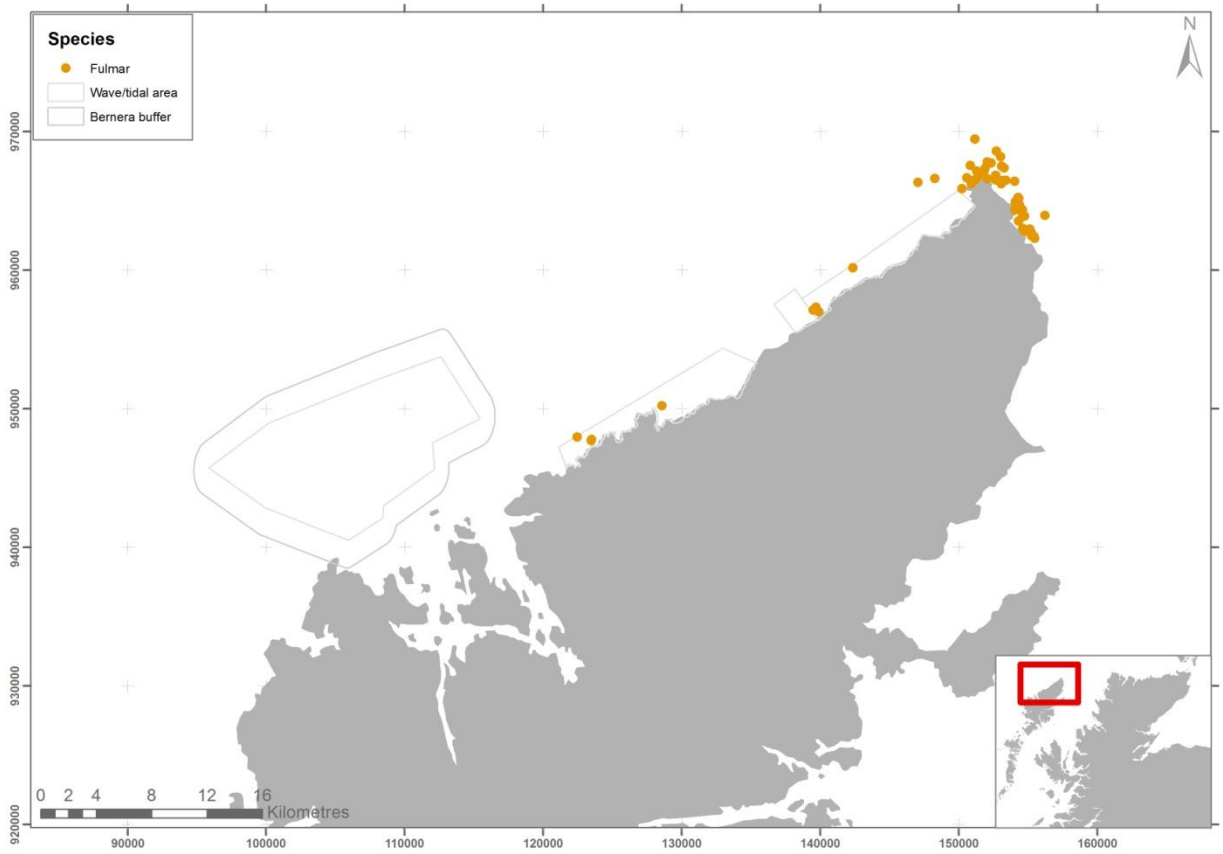


Figure 60 – June gannet records from ground-based counts

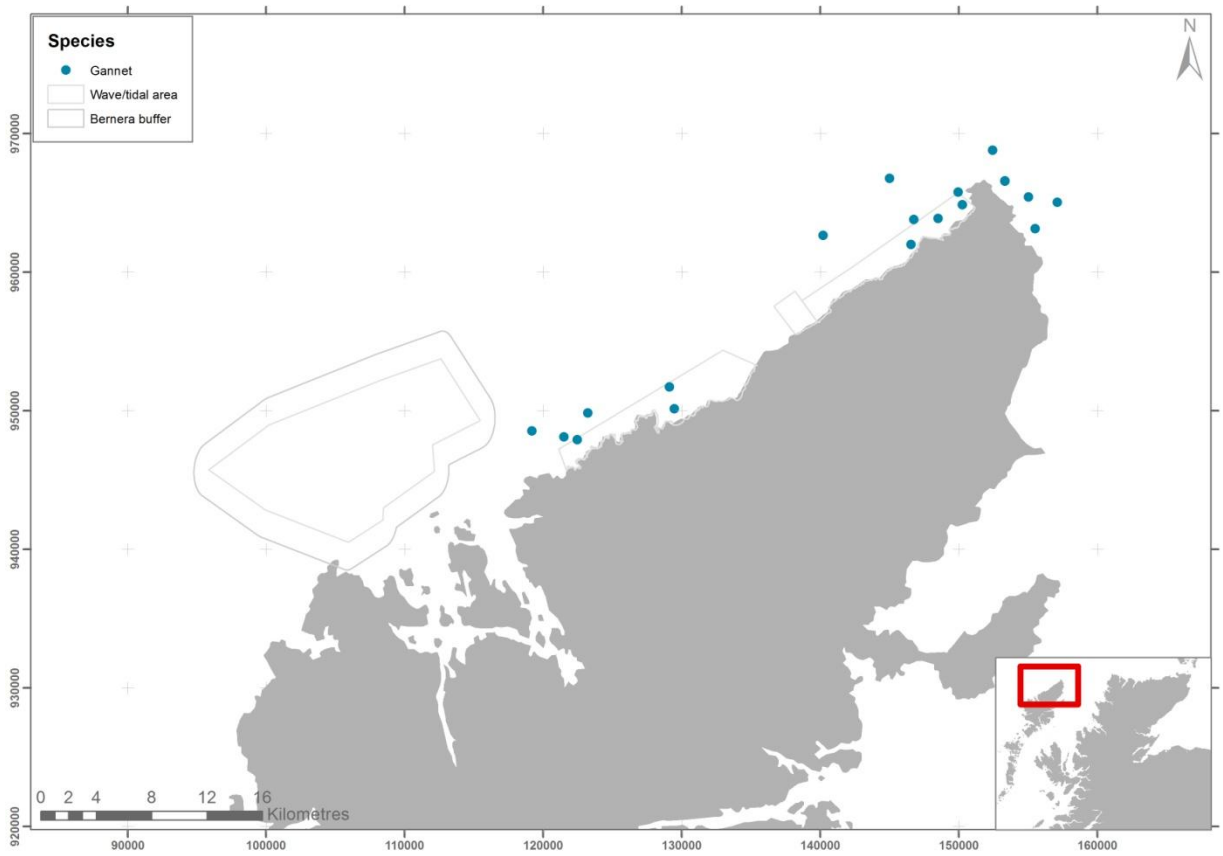


Figure 61 – June gull and skua records from ground-based counts

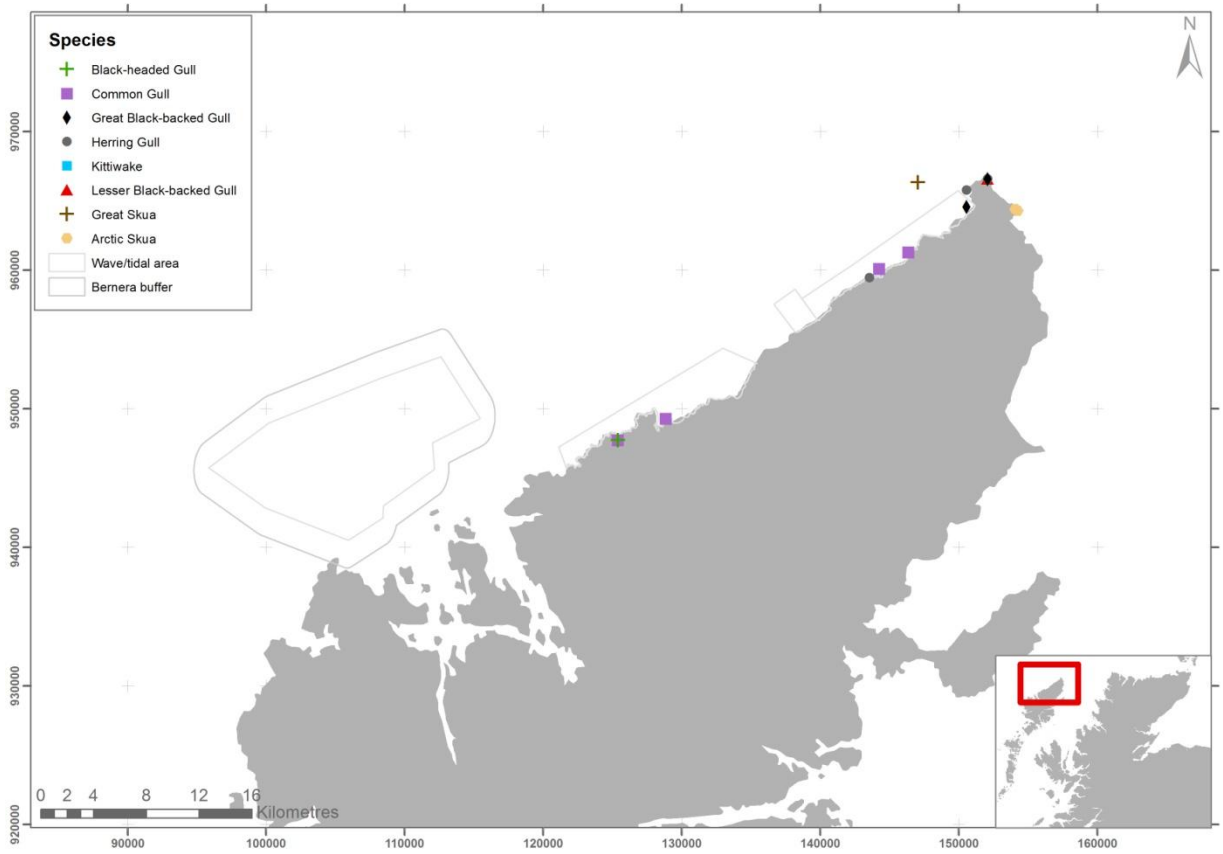


Figure 62 – June auk records from ground-based counts

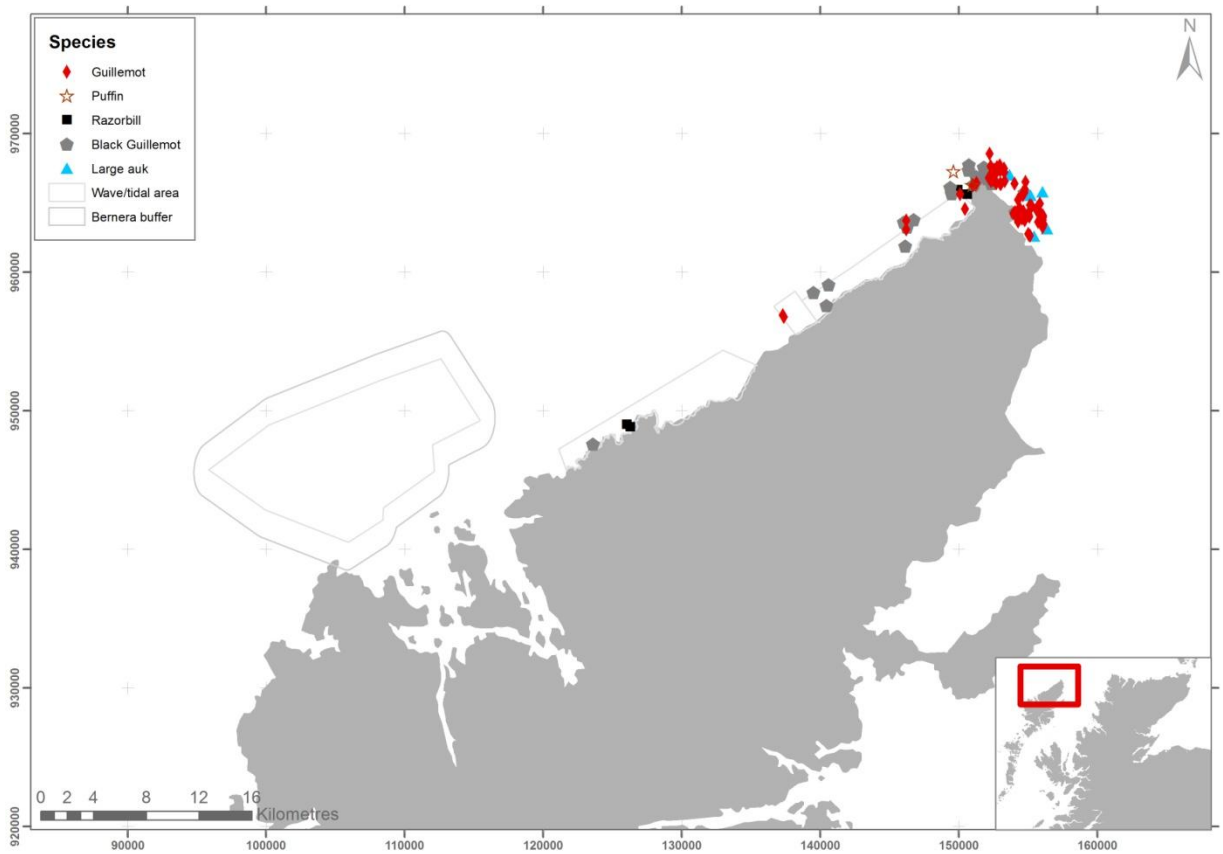


Figure 63 – June cetacean and marine mammal records from ground-based counts

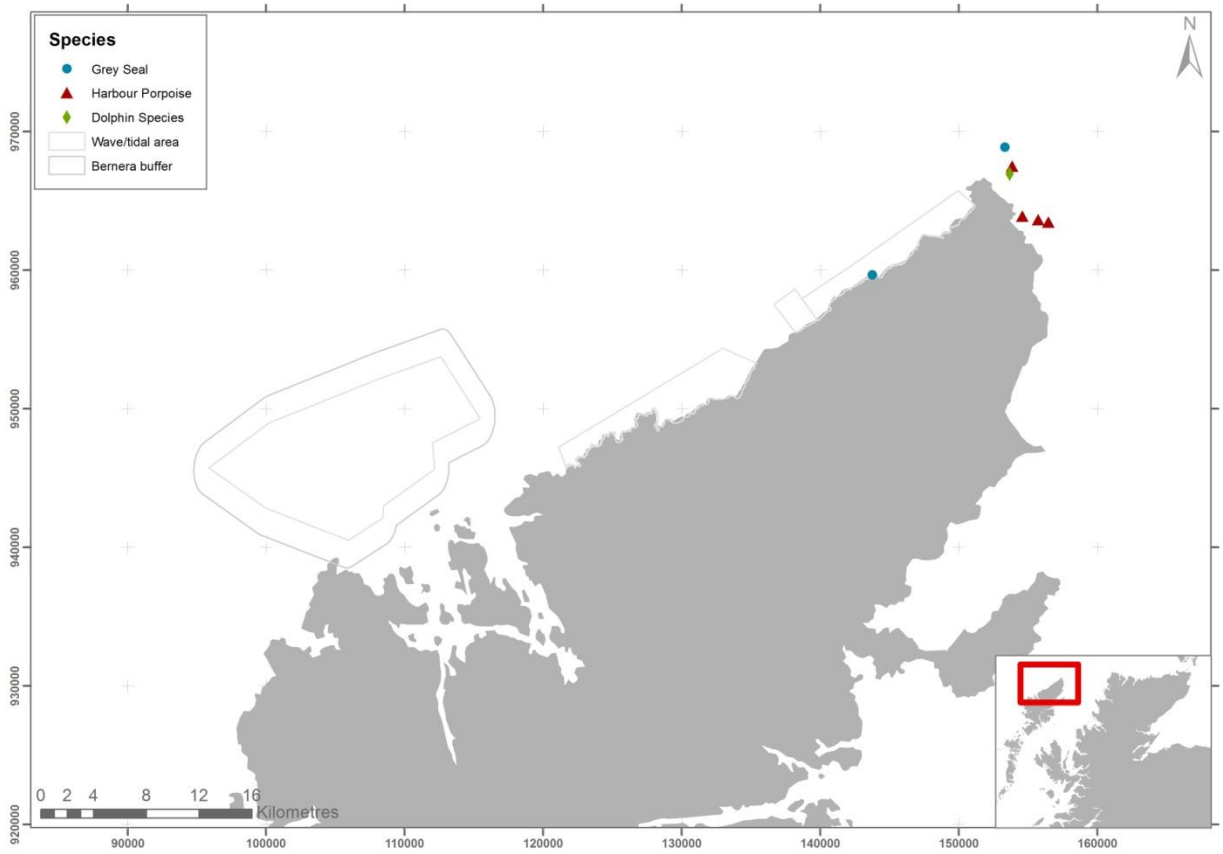


Figure 64 – July shag and diver species records from ground-based counts

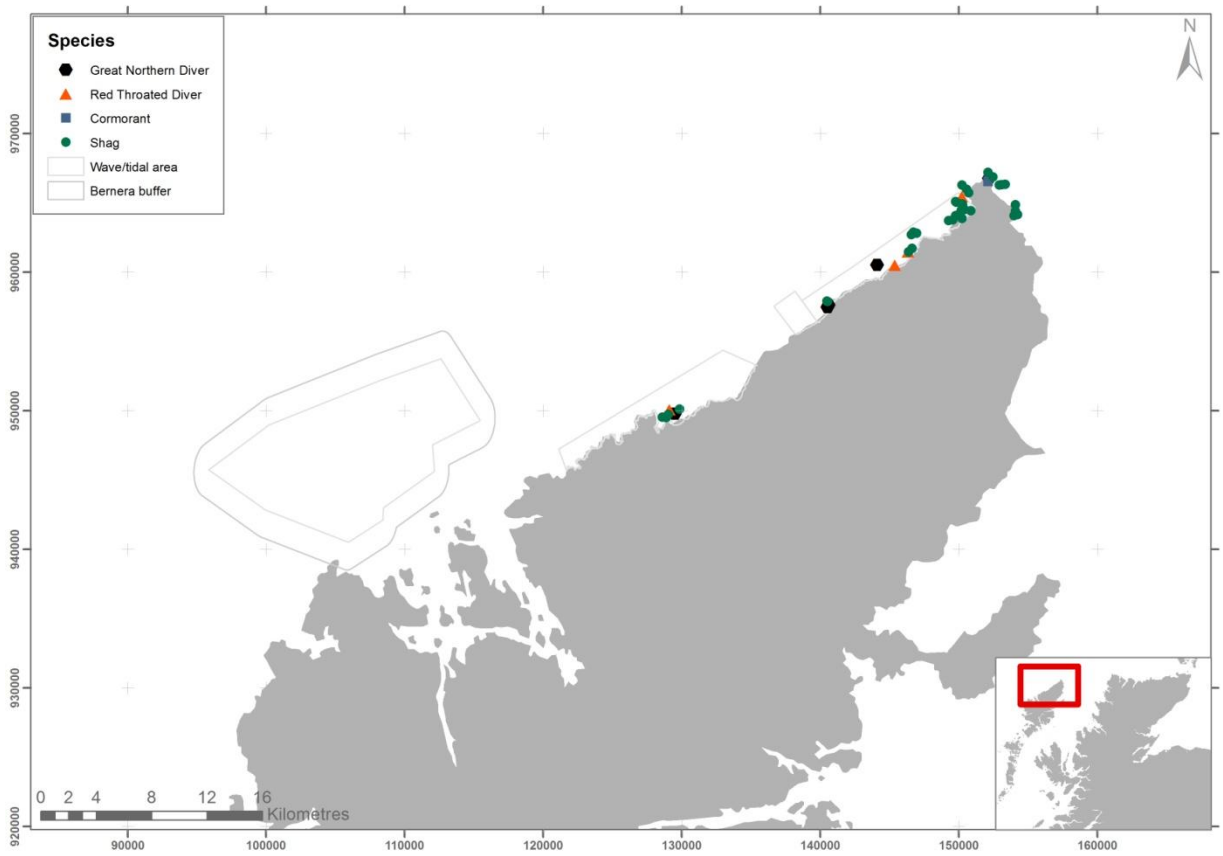


Figure 65 – July fulmar records from ground-based counts

Figure 66 – July gannet records from ground-based counts

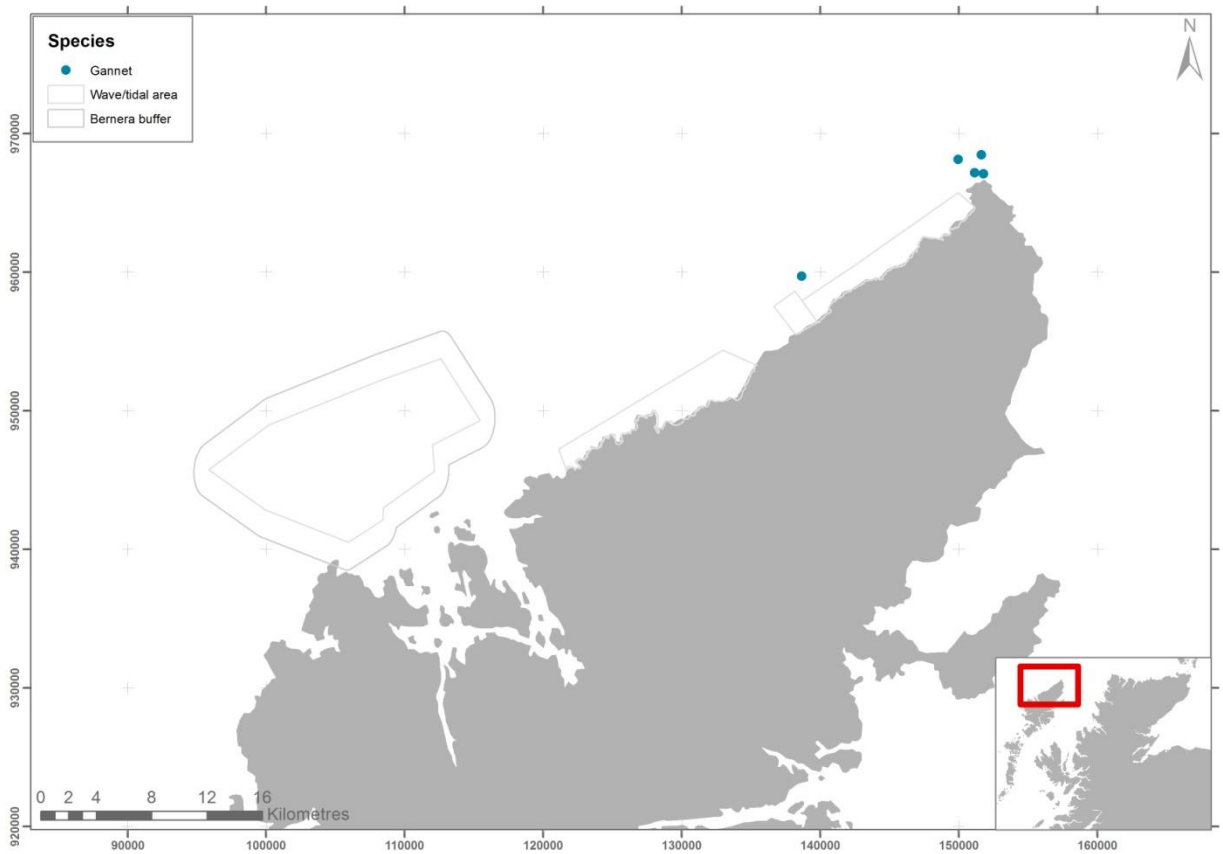


Figure 67 – July gull and skua records from ground-based counts

Figure 68 – July auk records from ground-based counts

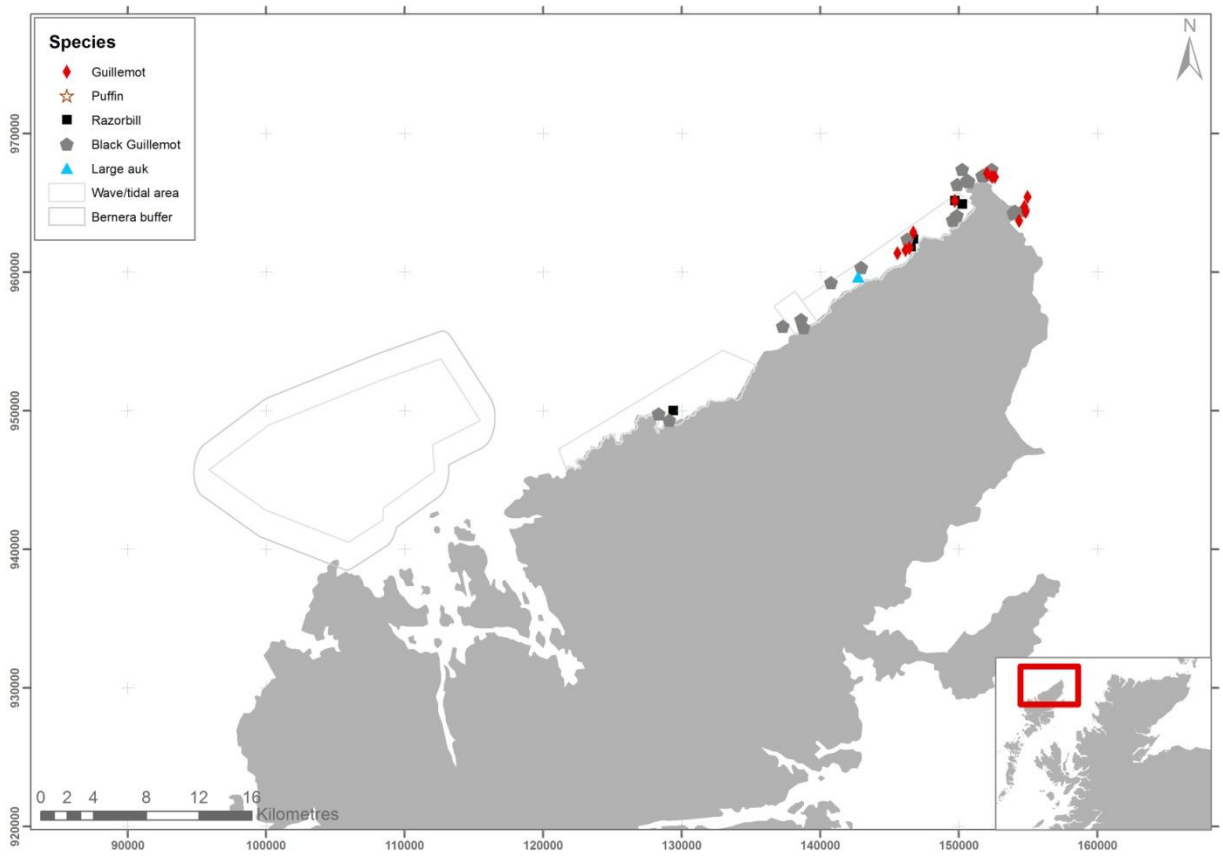


Figure 69 – July cetacean and marine mammal records from ground-based counts

Figure 70 – September diver and cormorant records from ground based counts

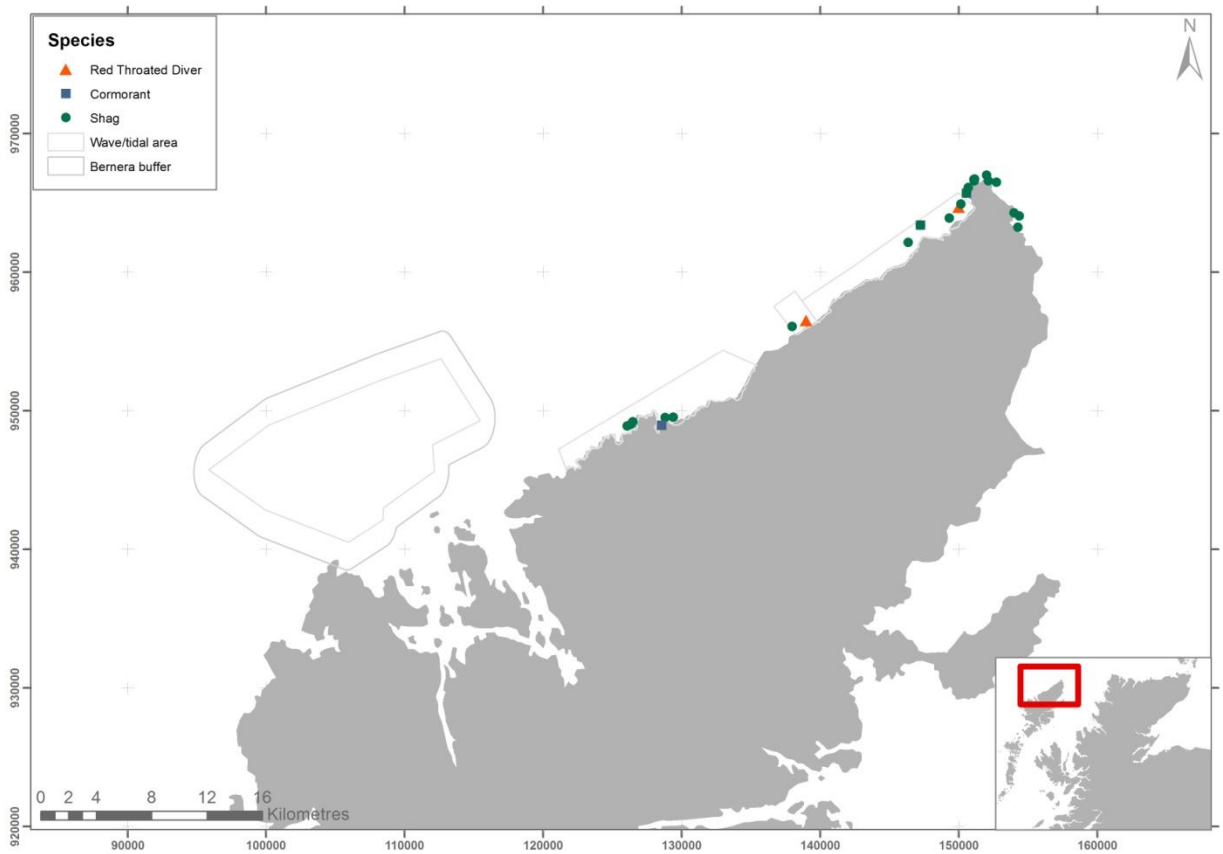


Figure 71 - September gannet records from ground based counts

Figure 72 - September gull records from ground based counts

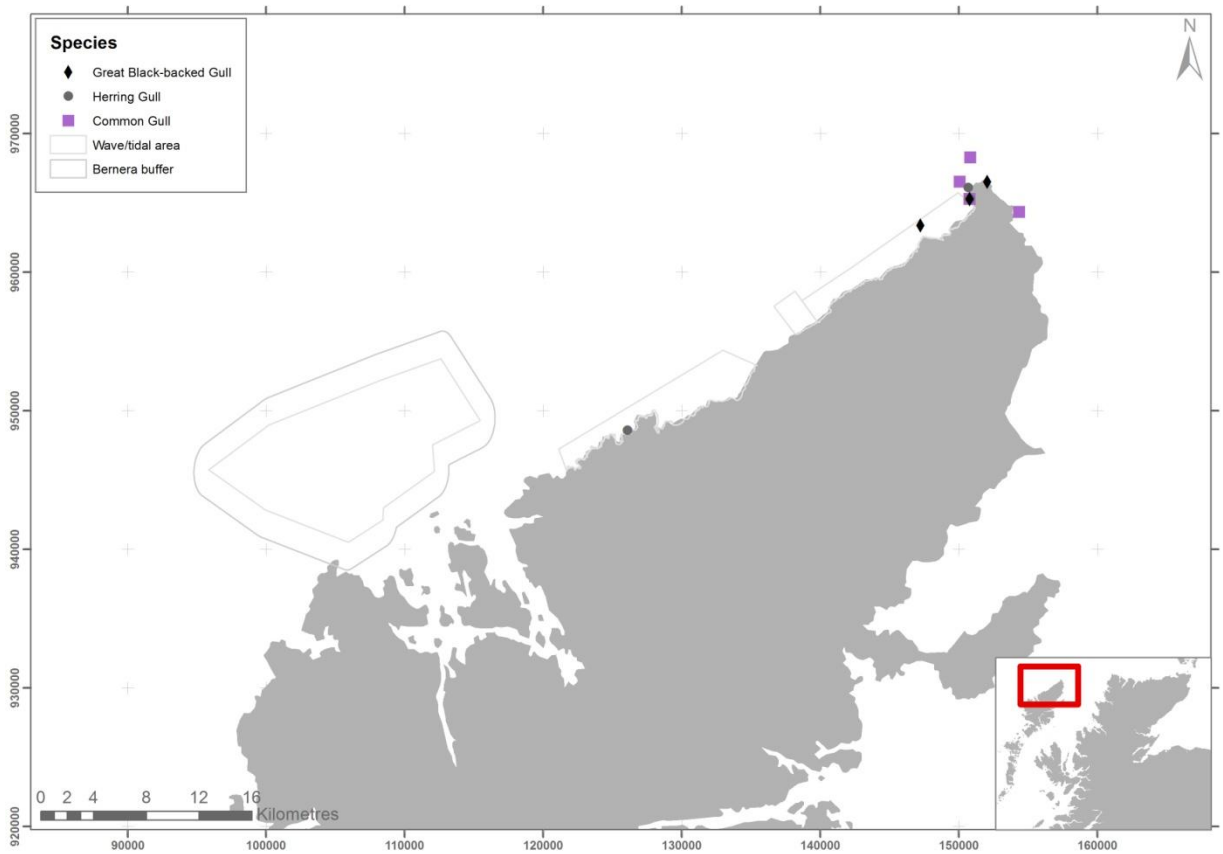


Figure 73 – September auk records from ground based counts

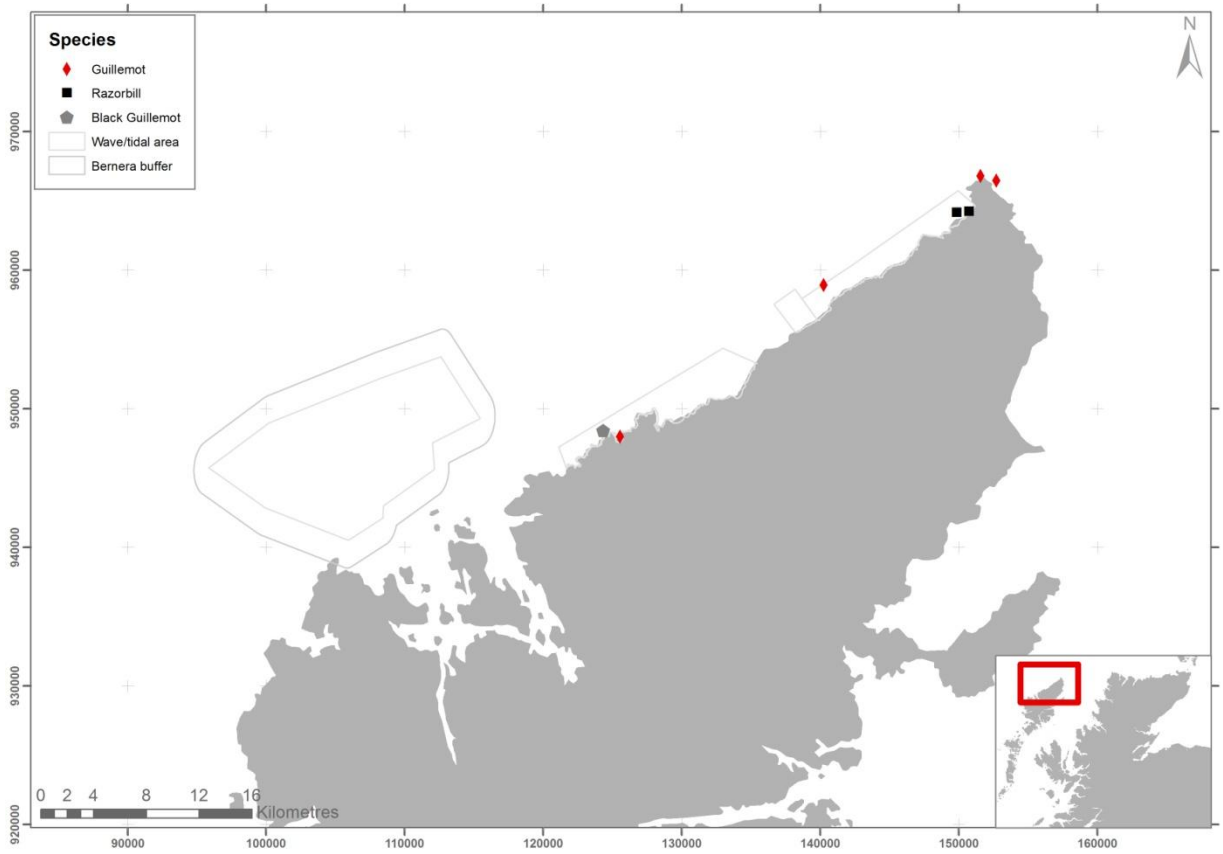


Figure 74 - September shark and seal records from ground based counts

Figure 75 – December duck, diver and cormorant records from ground based counts

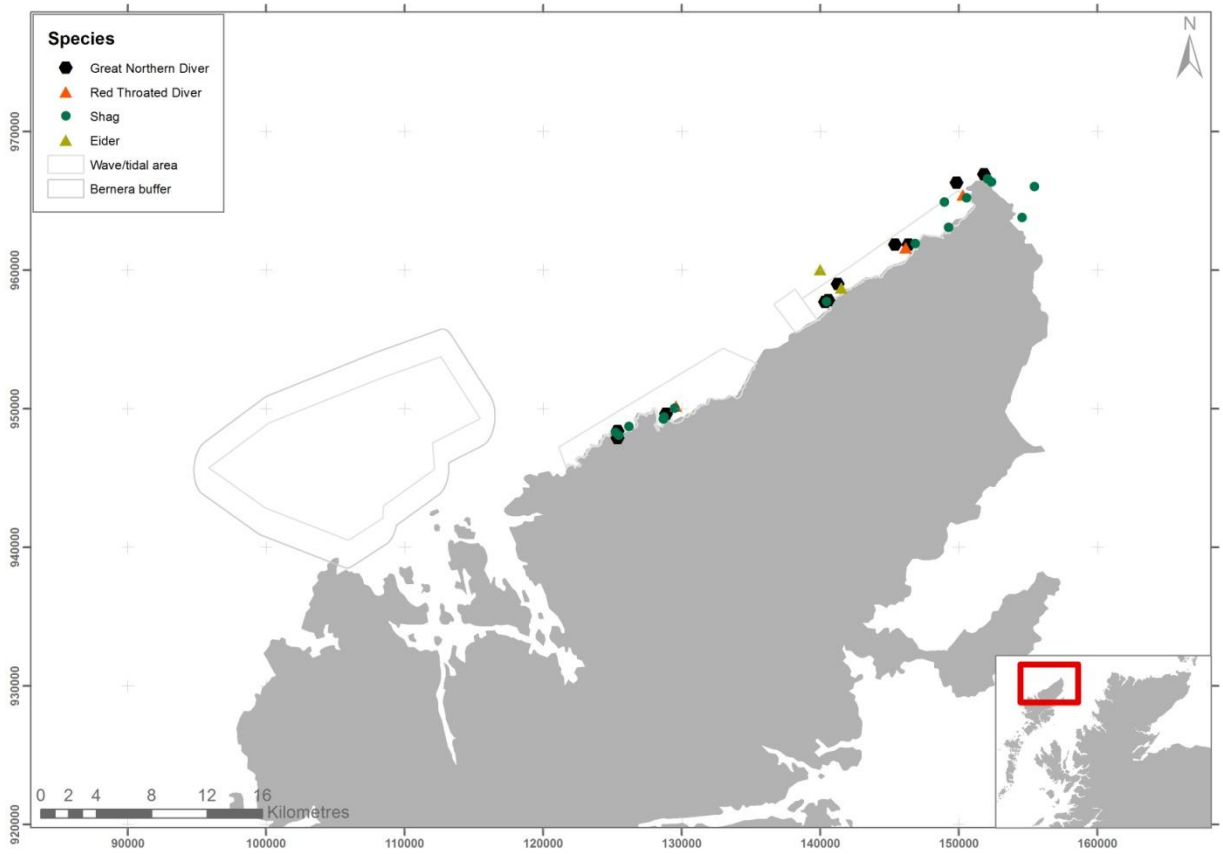


Figure 76 - December fulmar records from ground based counts

Figure 77 – December gull records from ground based counts

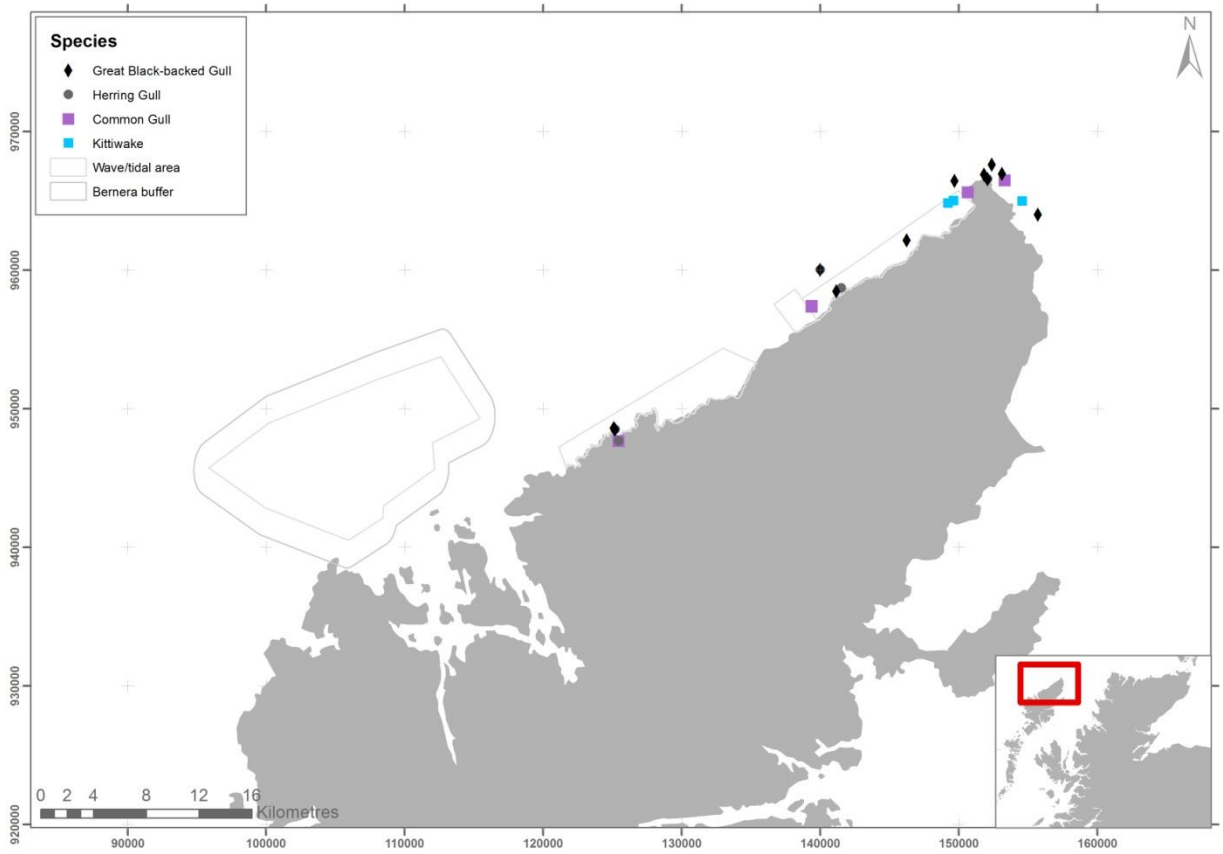


Figure 78 – December auk records from ground based counts

Figure 79 - February duck, diver and cormorant records from ground based counts

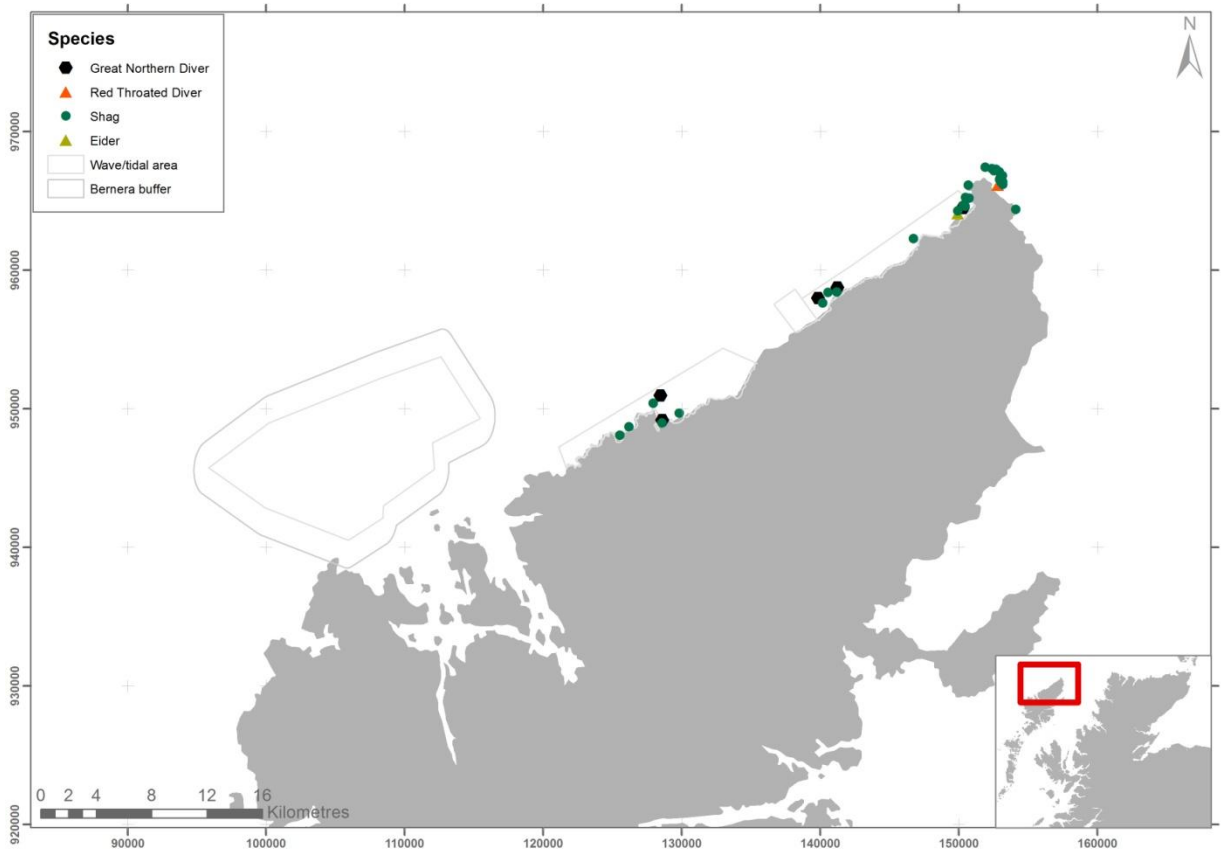


Figure 80 - February fulmar records from ground based counts

Figure 81 - February gannet records from ground based counts

Figure 82 - February gull records from ground based counts

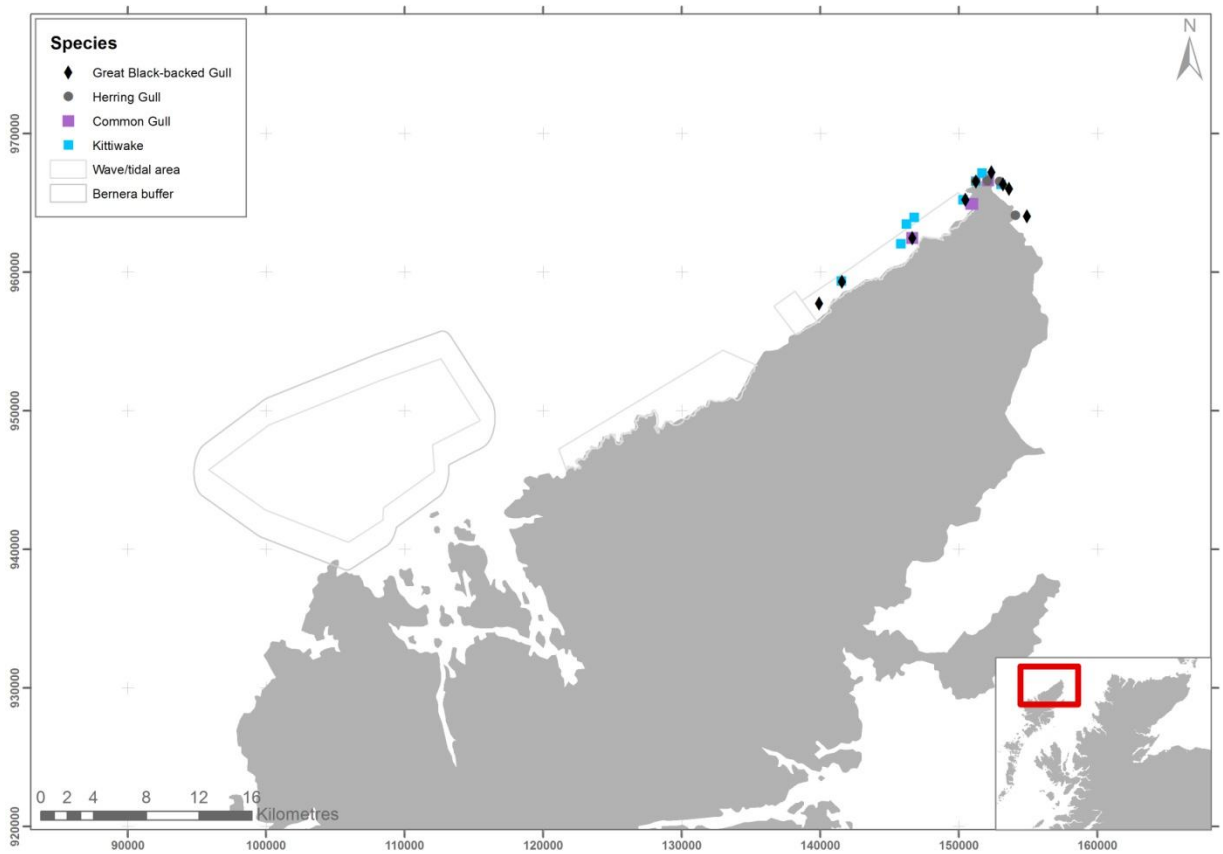


Figure 83 - February auk records from ground based counts

Figure 84 - February seal records from ground based counts

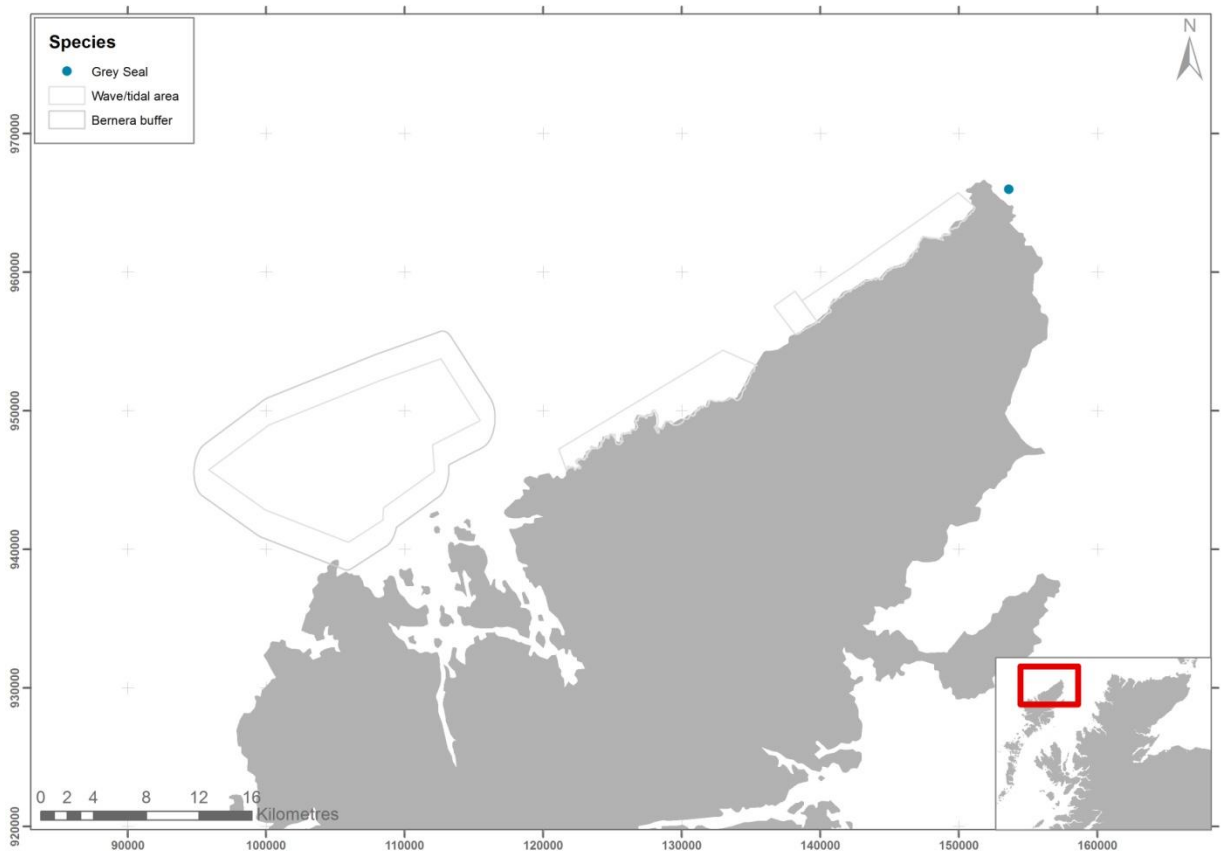


Figure 85 - Loch Roag coverage by 1km squares during the April, June and October 2012 survey visits

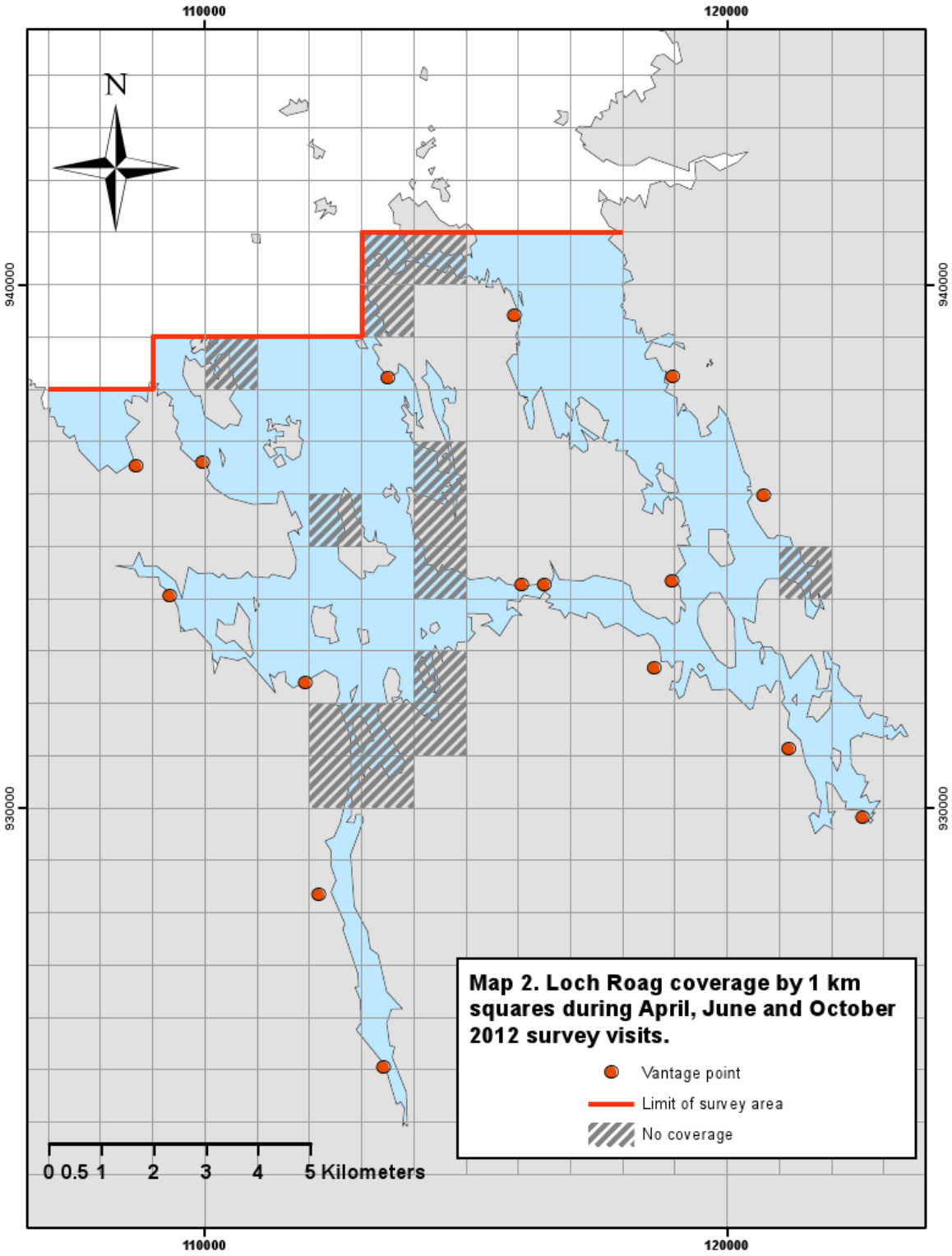


Figure 86 - Loch Roag coverage by 1km squares during the July 2012 survey visit

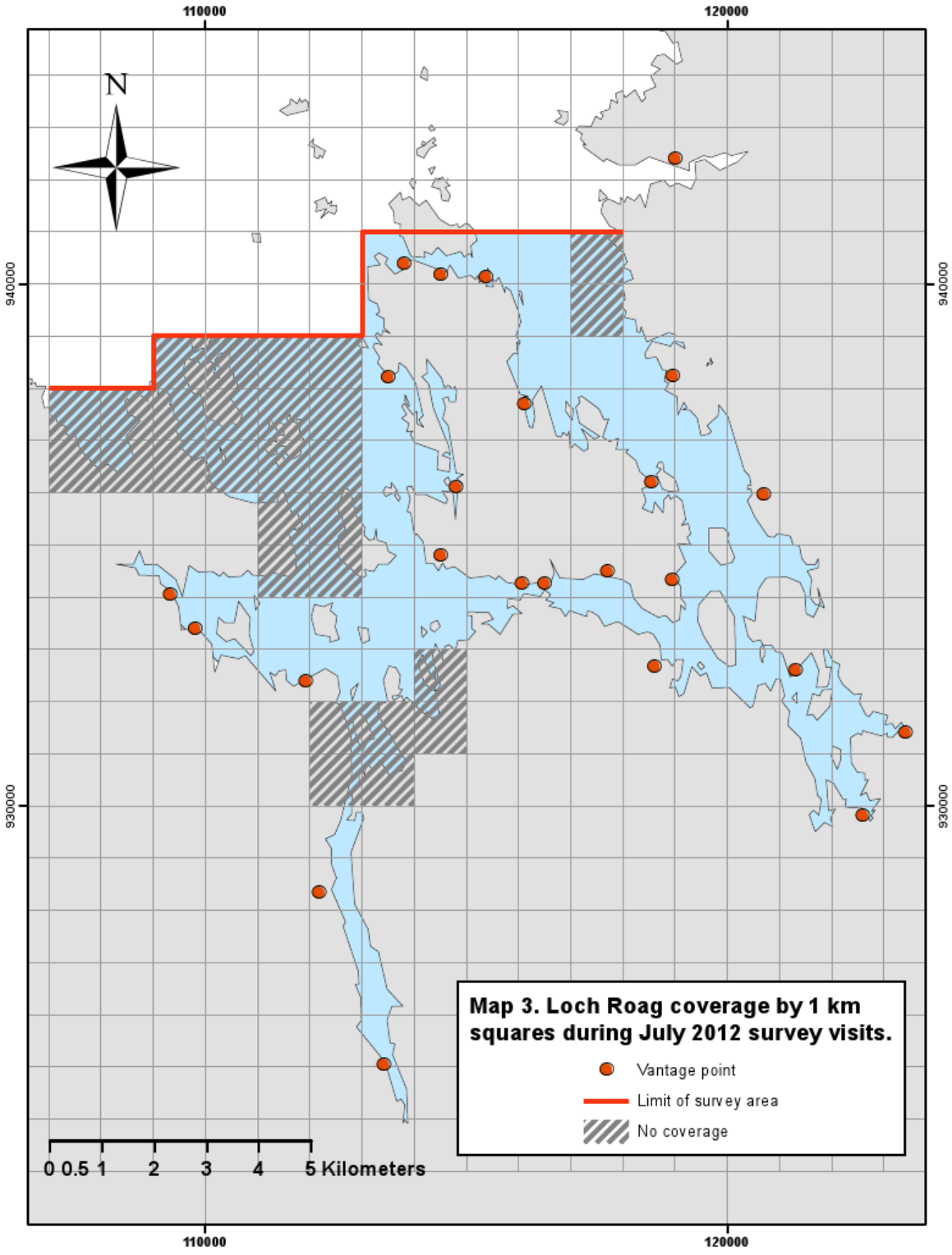


Figure 87 - Loch Roag coverage by 1km squares during the January and February 2013 visits

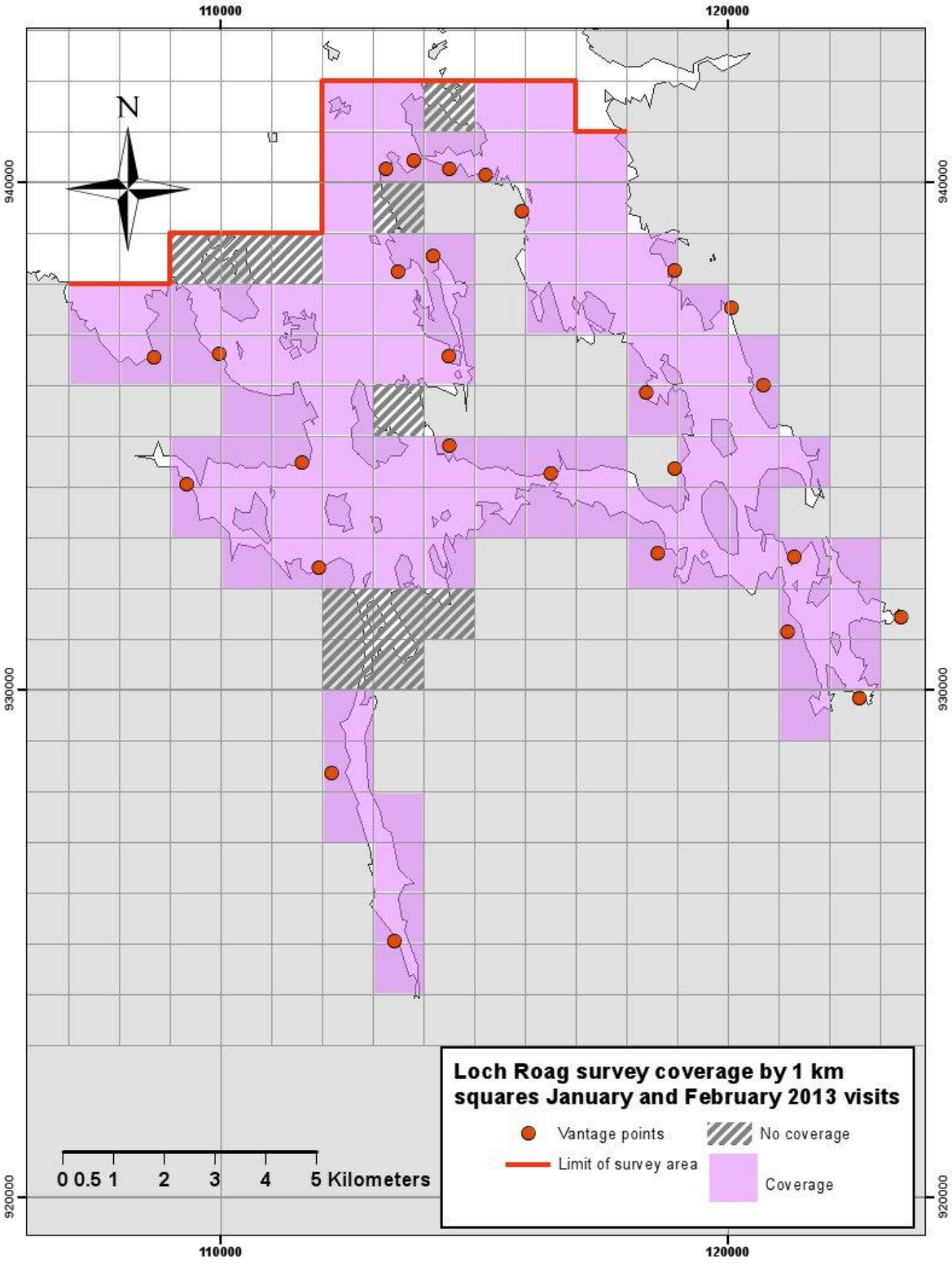


Figure 88 - Red-throated diver distribution by 1km square and cumulative abundance, April 2012 – February 2013

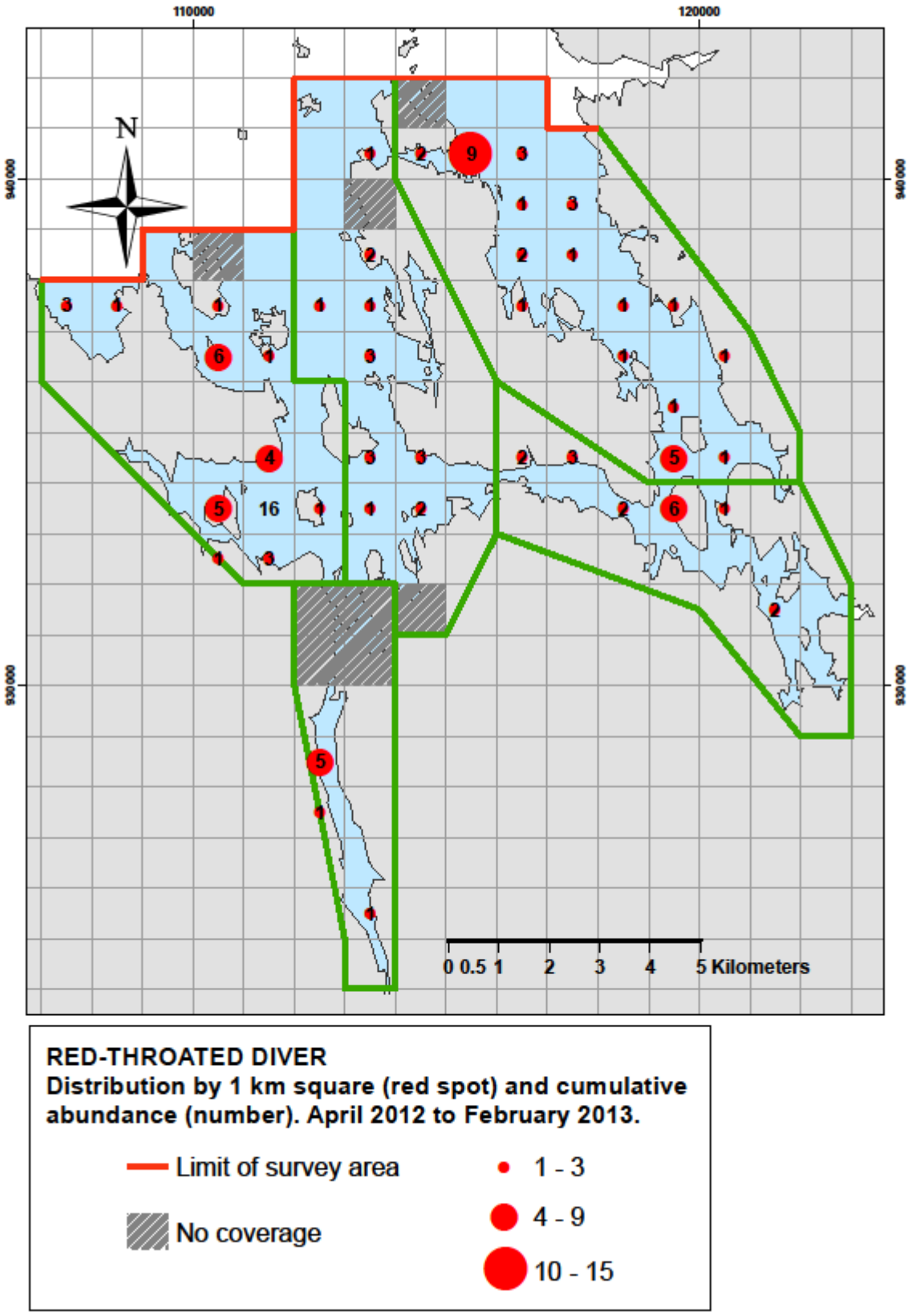


Figure 89 - Black-throated diver distribution by 1km square and cumulative abundance, April 2012 – February 2013

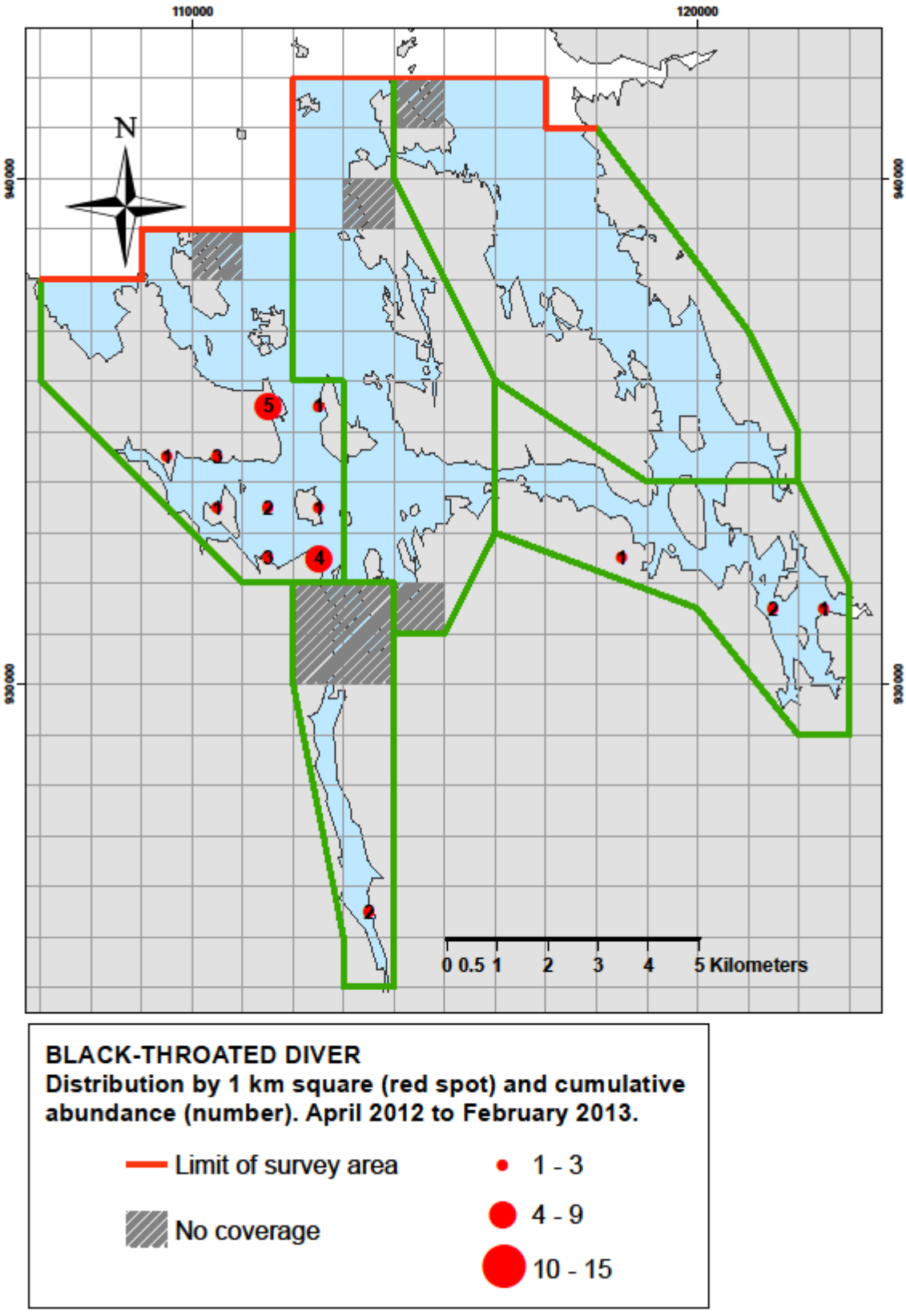


Figure 90 - Great northern diver distribution by 1km square and cumulative abundance, April 2012 – February 2013

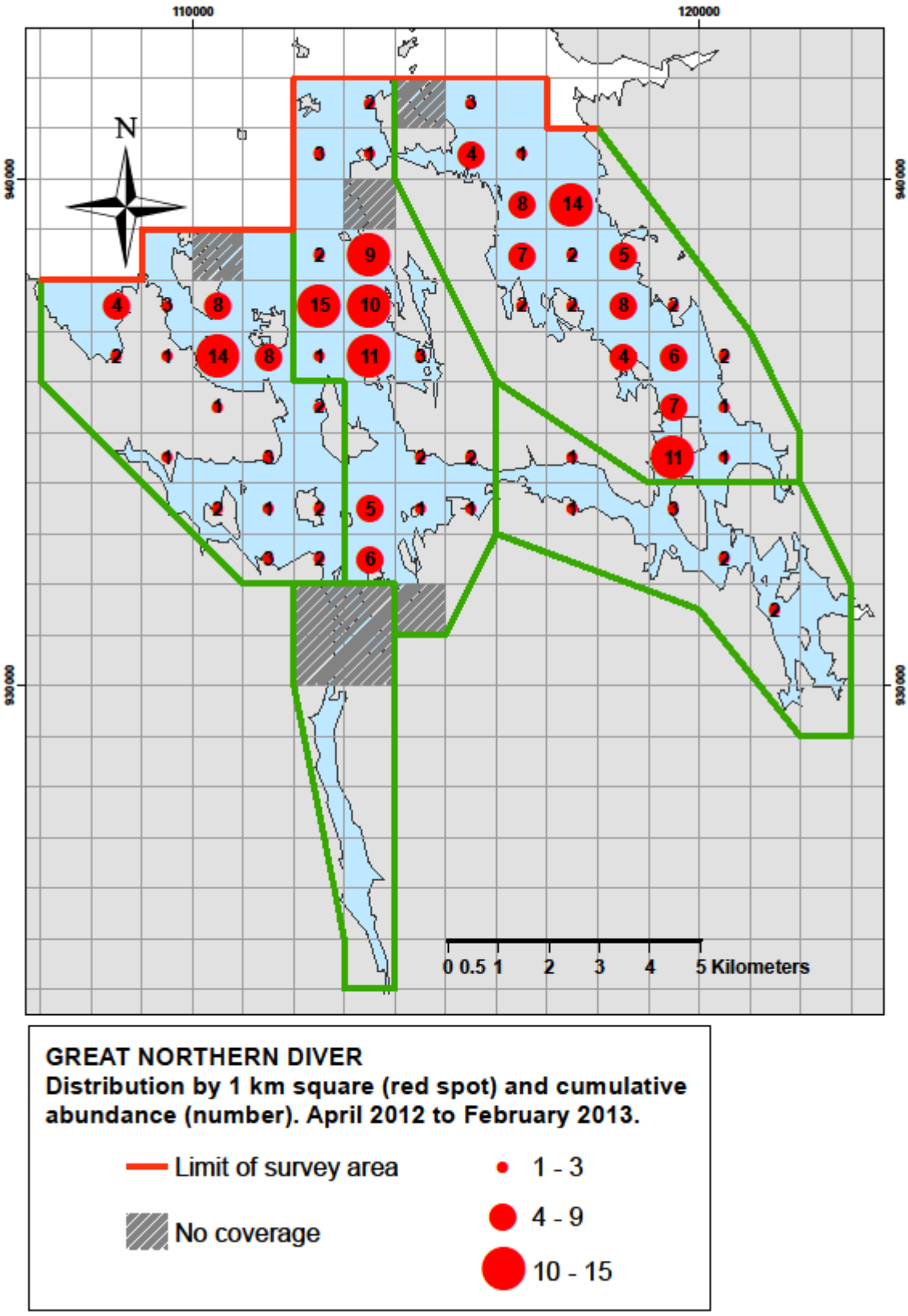


Figure 91 - Slavonian grebe distribution by 1km square and cumulative abundance, April 2012 – February 2013

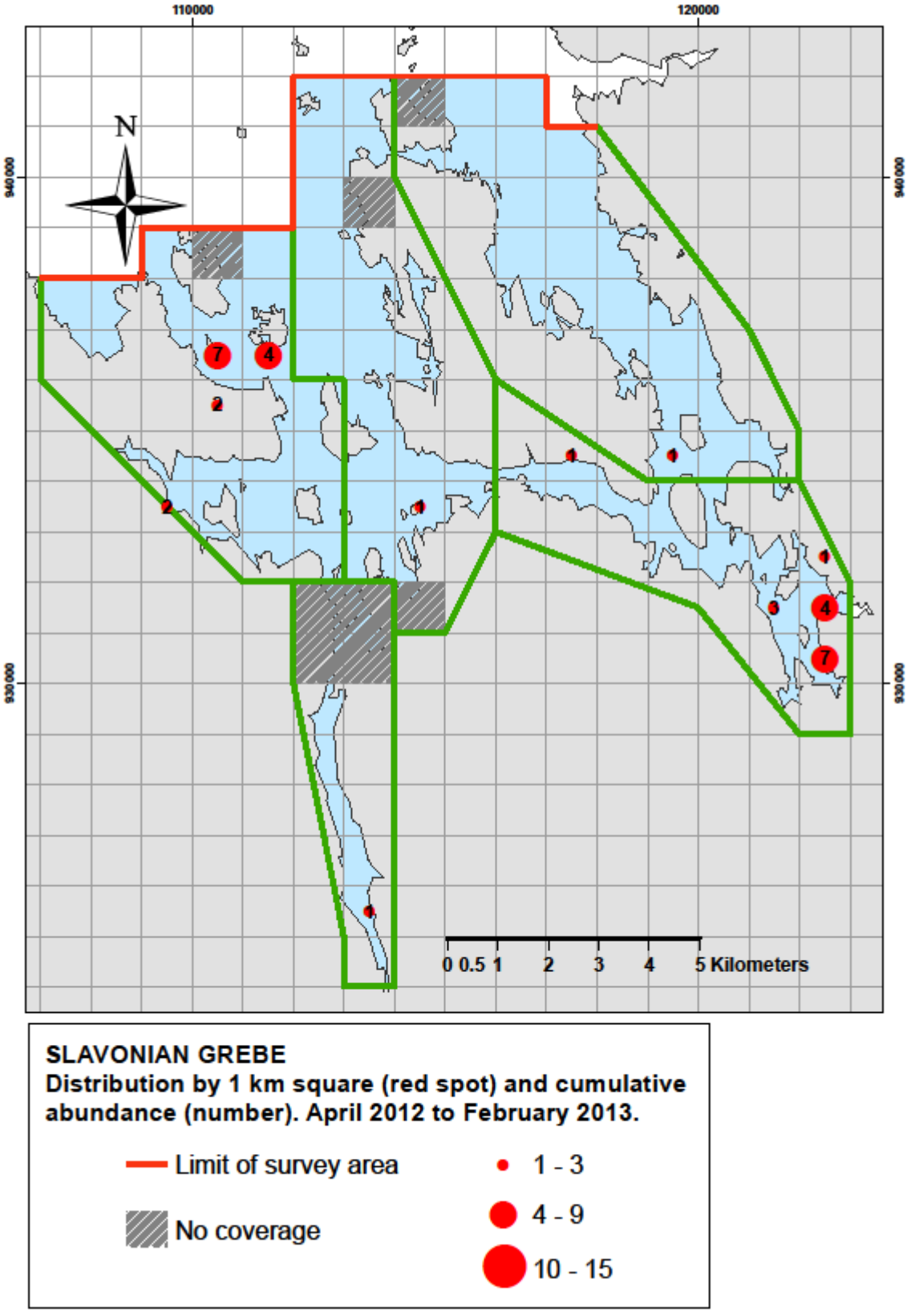


Figure 92 - Cormorant distribution by 1km square and cumulative abundance, April 2012 – February 2013

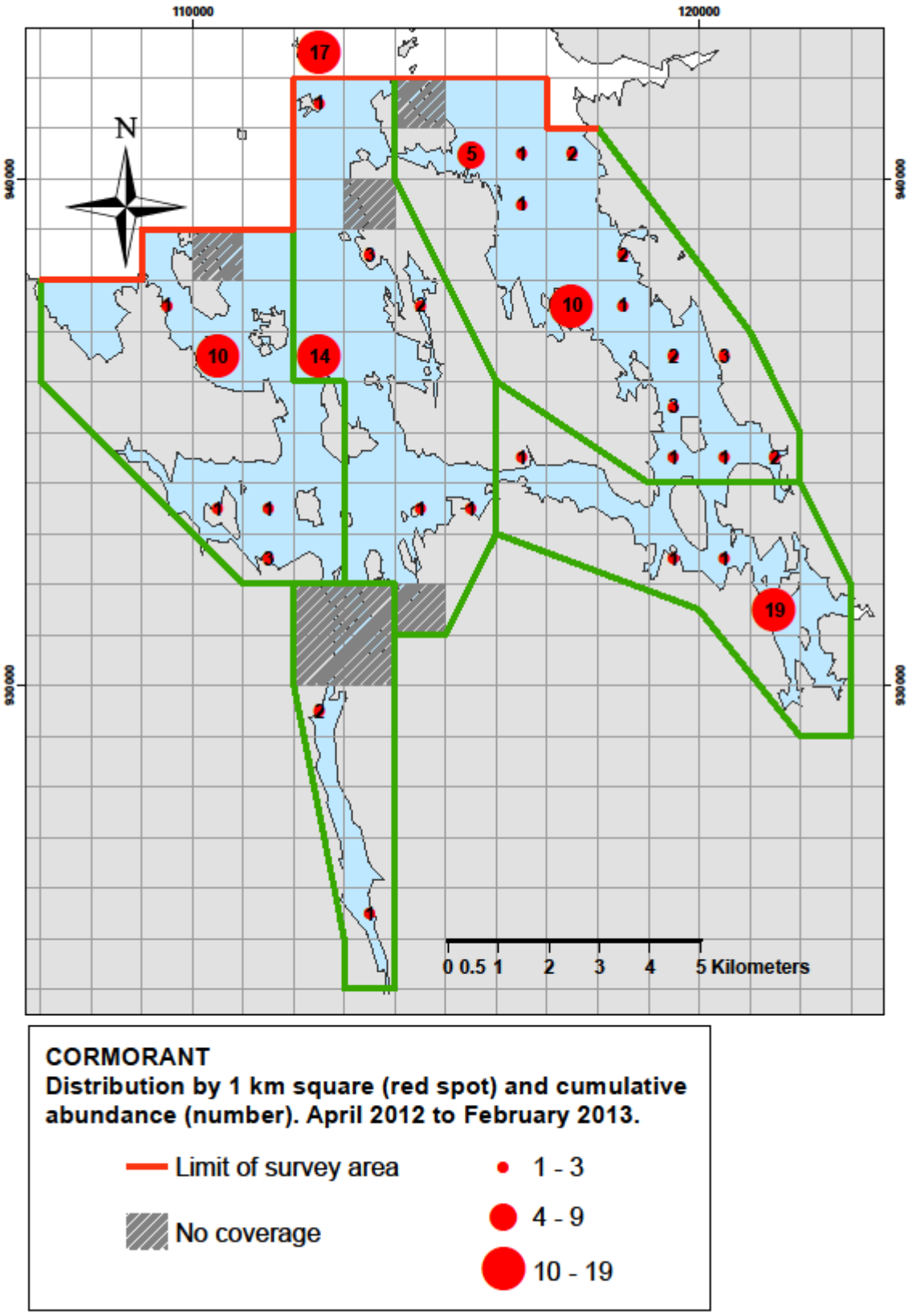


Figure 93 - Shag distribution by 1km square and cumulative abundance, April 2012 – February 2013

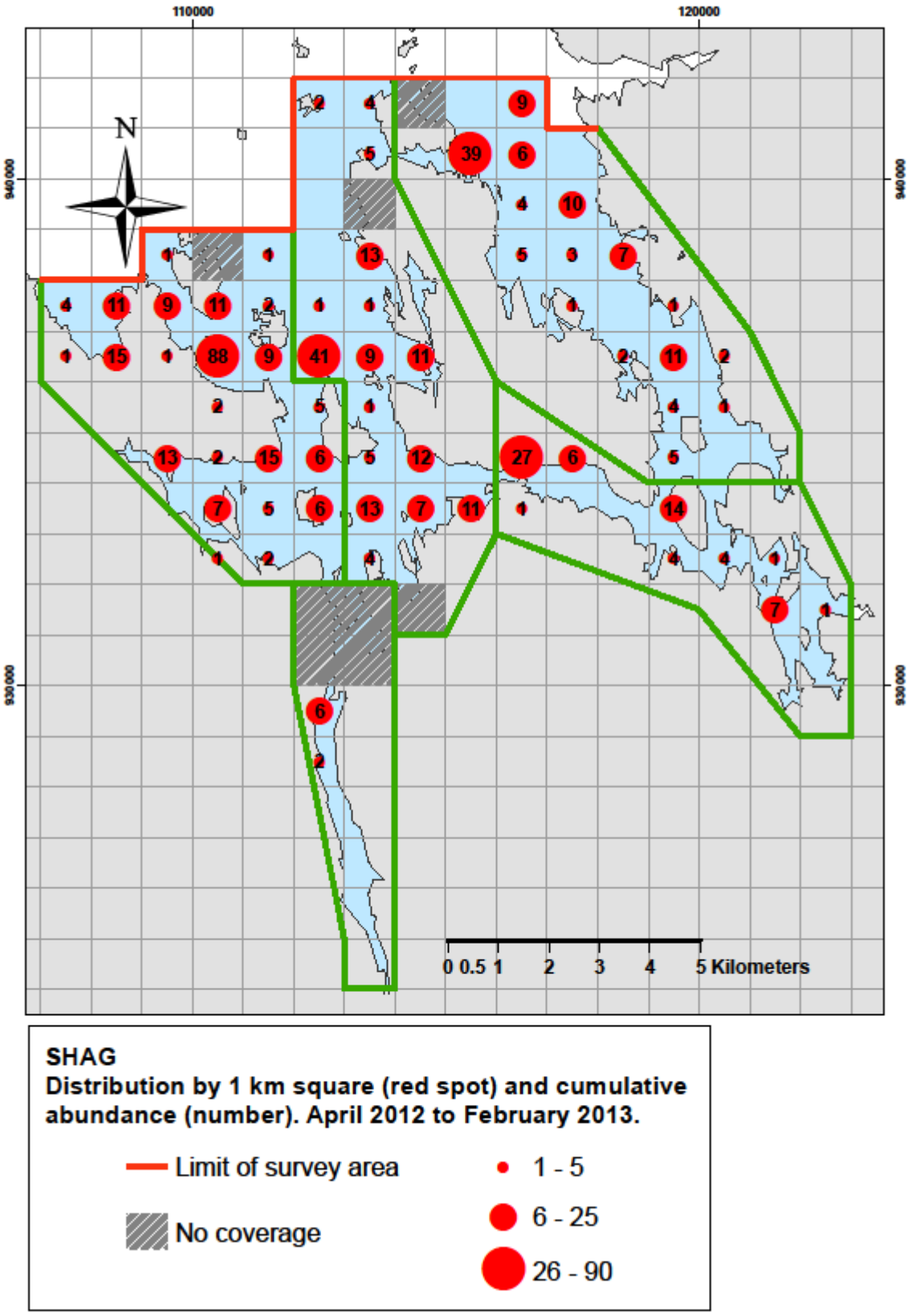


Figure 94 - Black guillemot distribution by 1km square and cumulative abundance, April 2012 – February 2013

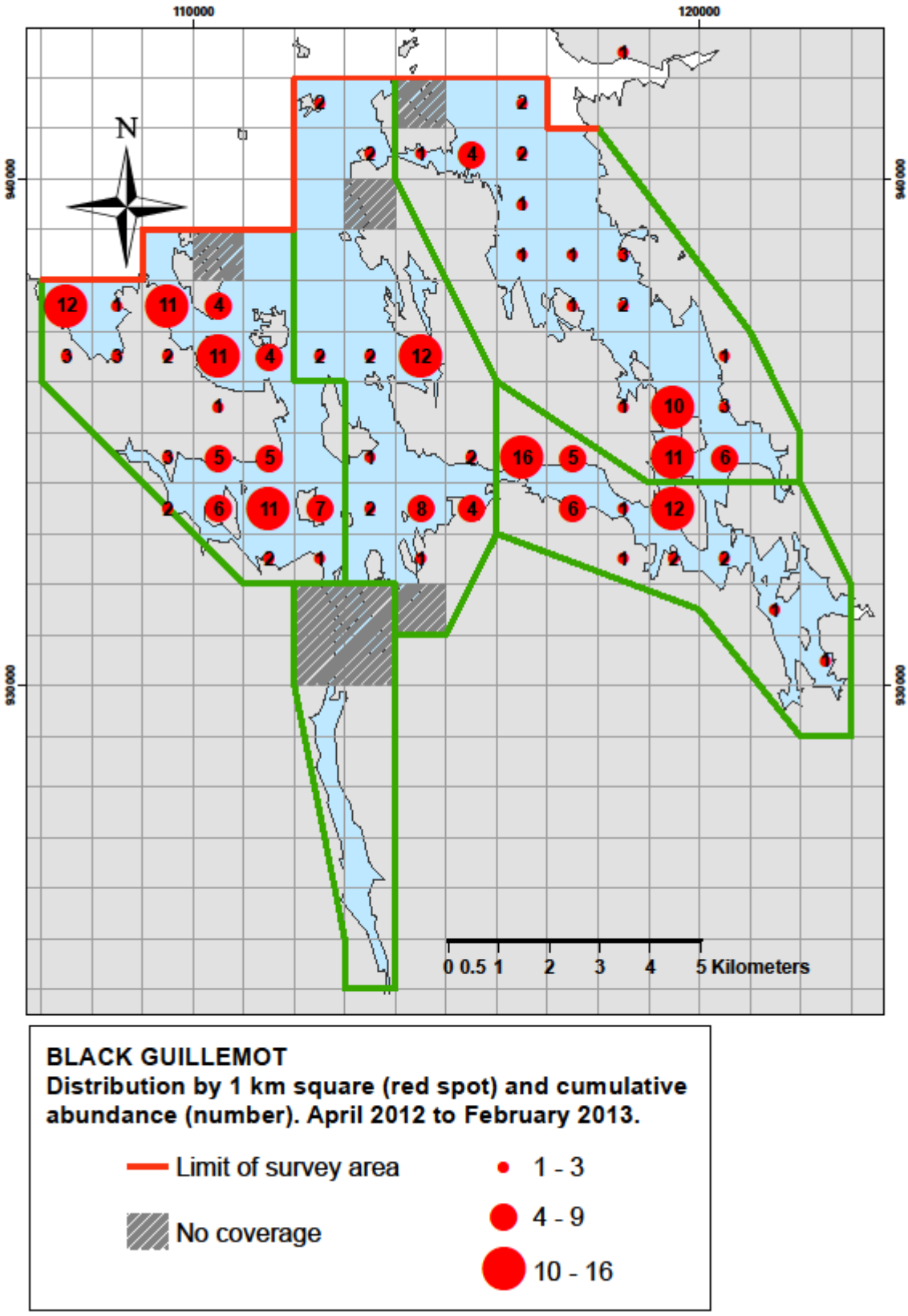


Figure 95 - Common seal and grey seal distribution by 1km square and abundance, October 2012

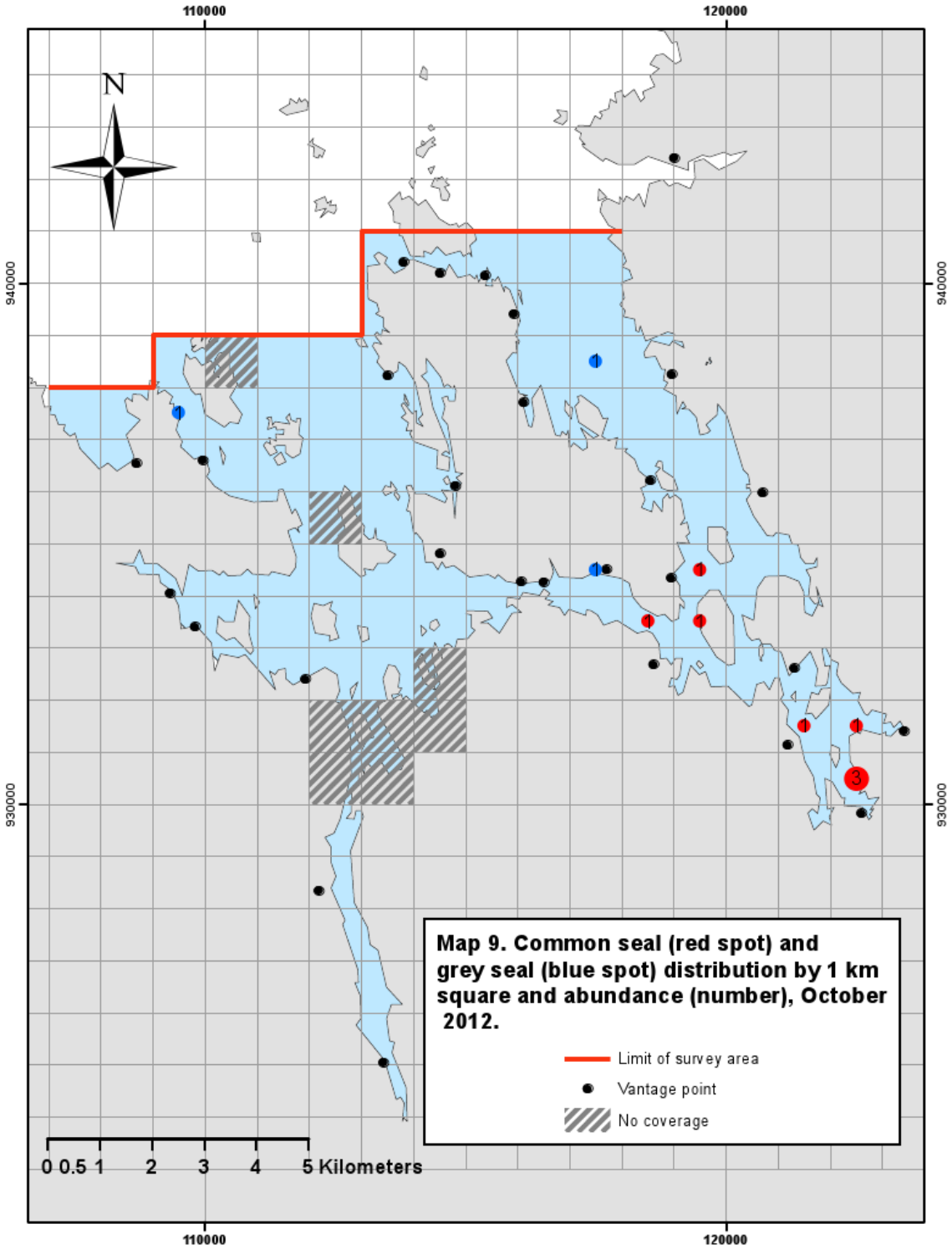


Figure 96 – April fulmar density surface model from digital aerial survey

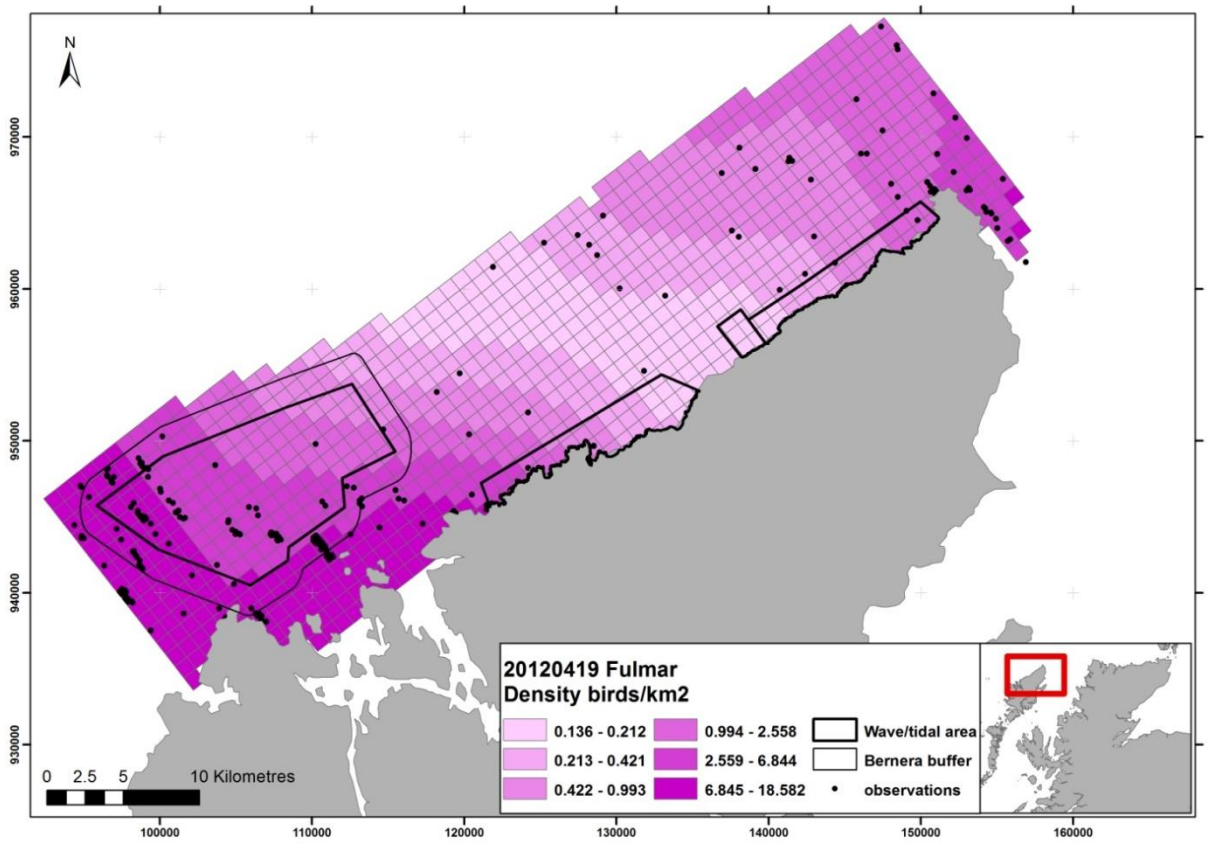


Figure 97 – April fulmar coefficient of variance map from digital aerial survey

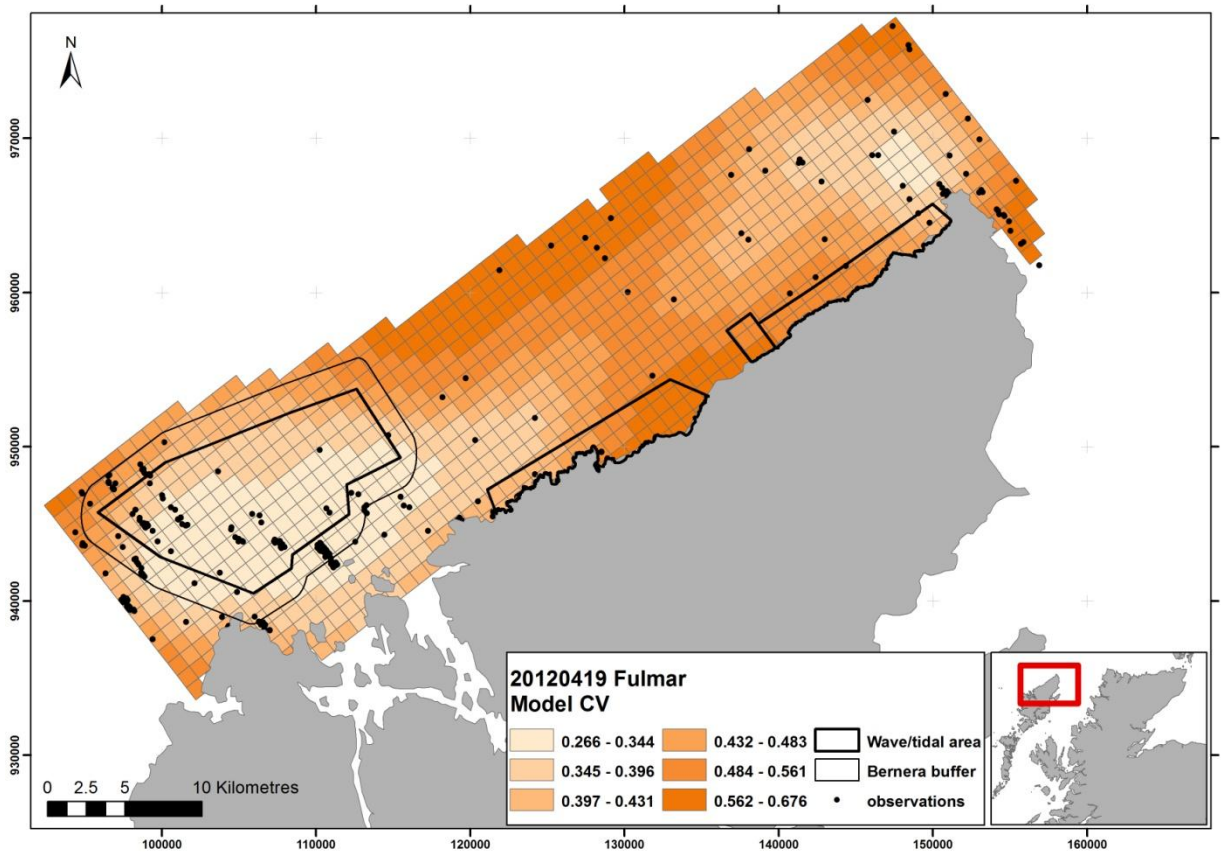


Figure 98 - April gannet density surface model from digital aerial survey

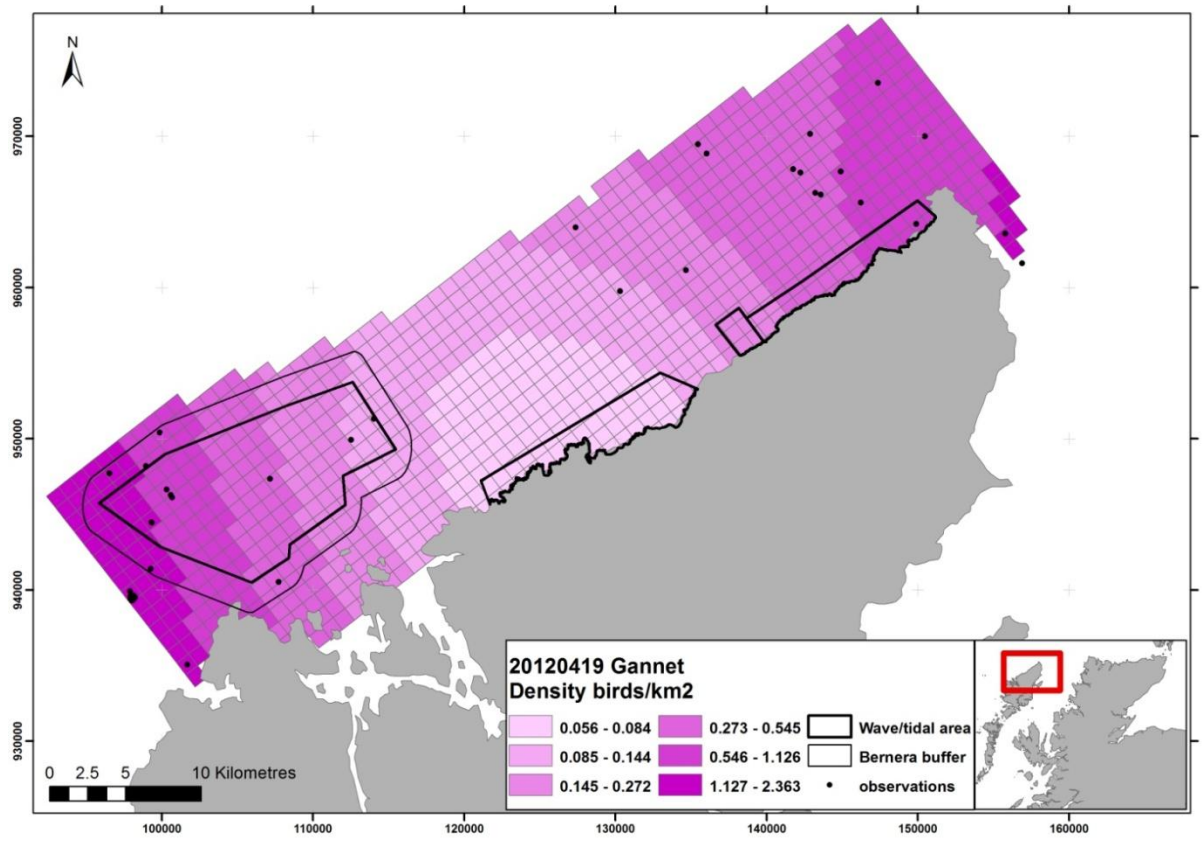


Figure 99 - April gannet coefficient of variance map from digital aerial survey

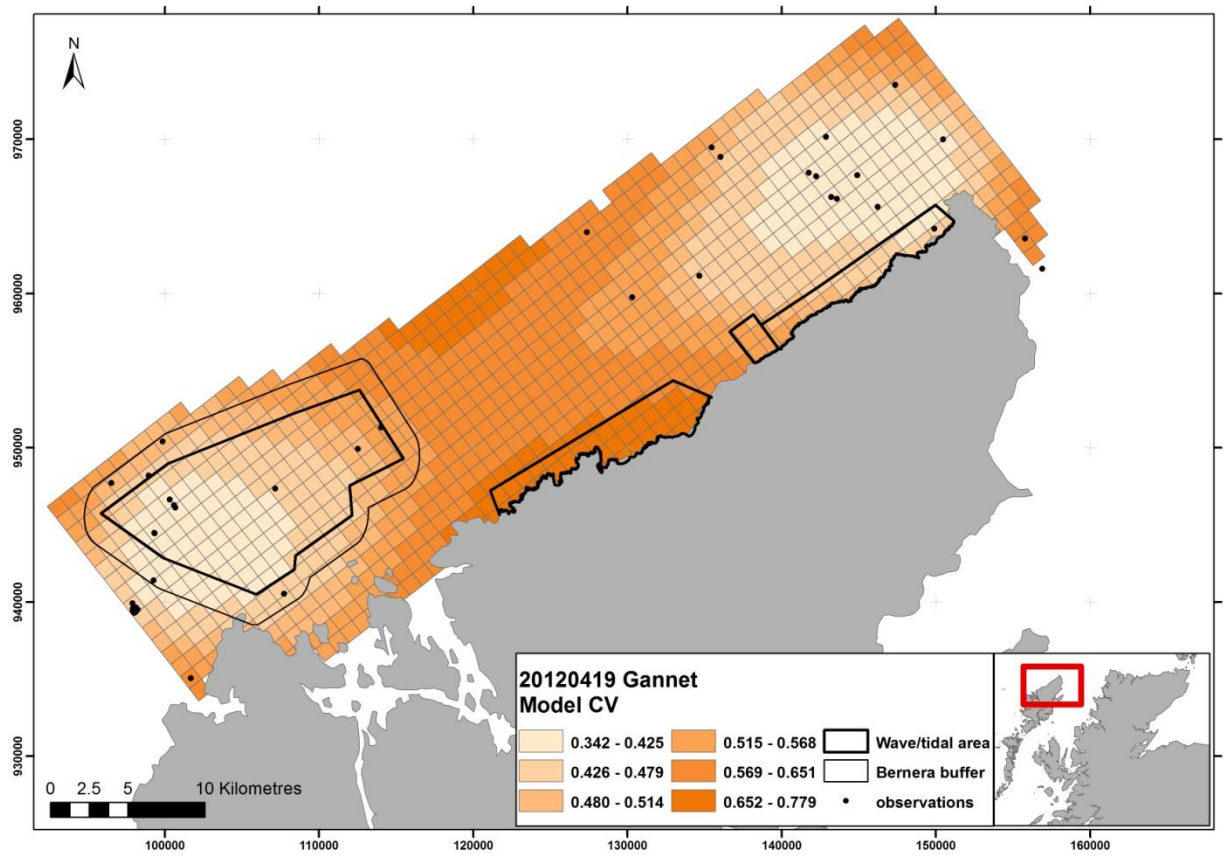


Figure 100 – April auk density surface model from digital aerial survey

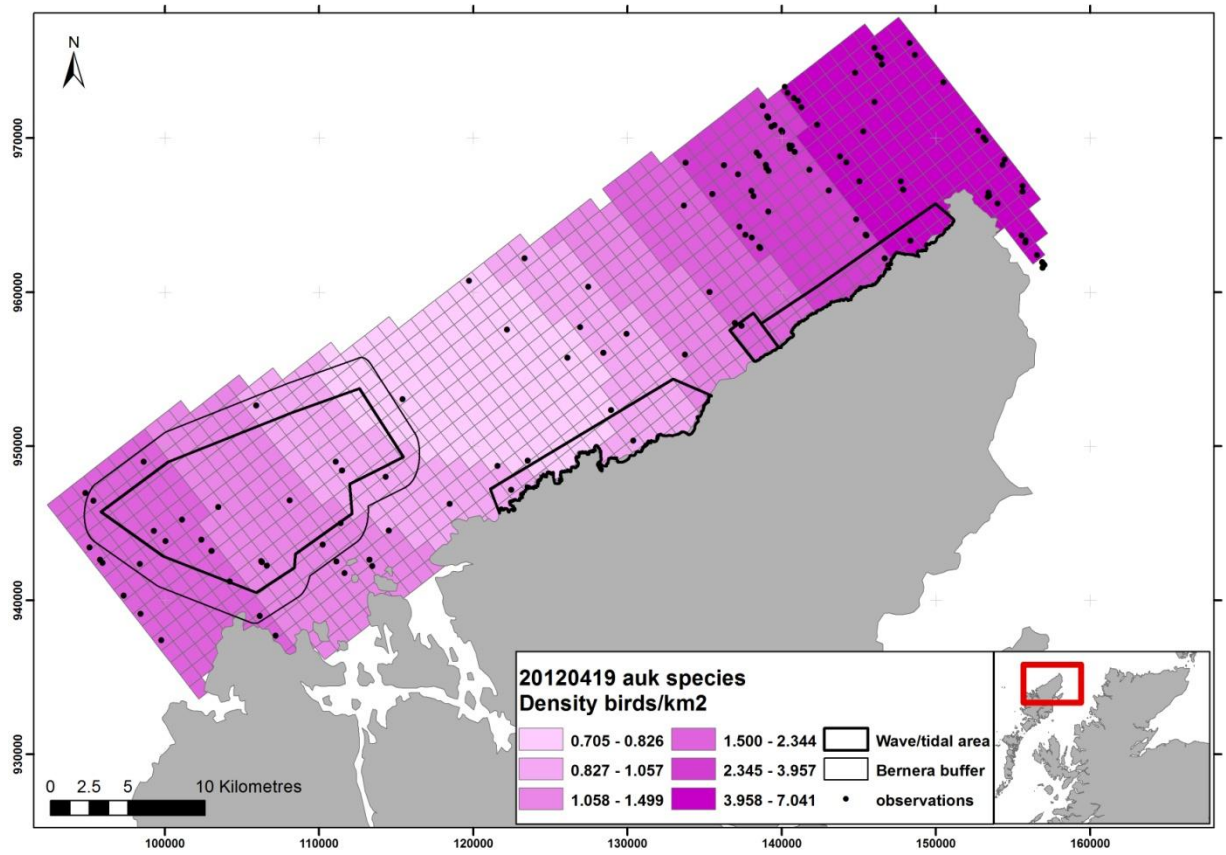


Figure 101 – April auk coefficient of variance map from digital aerial survey

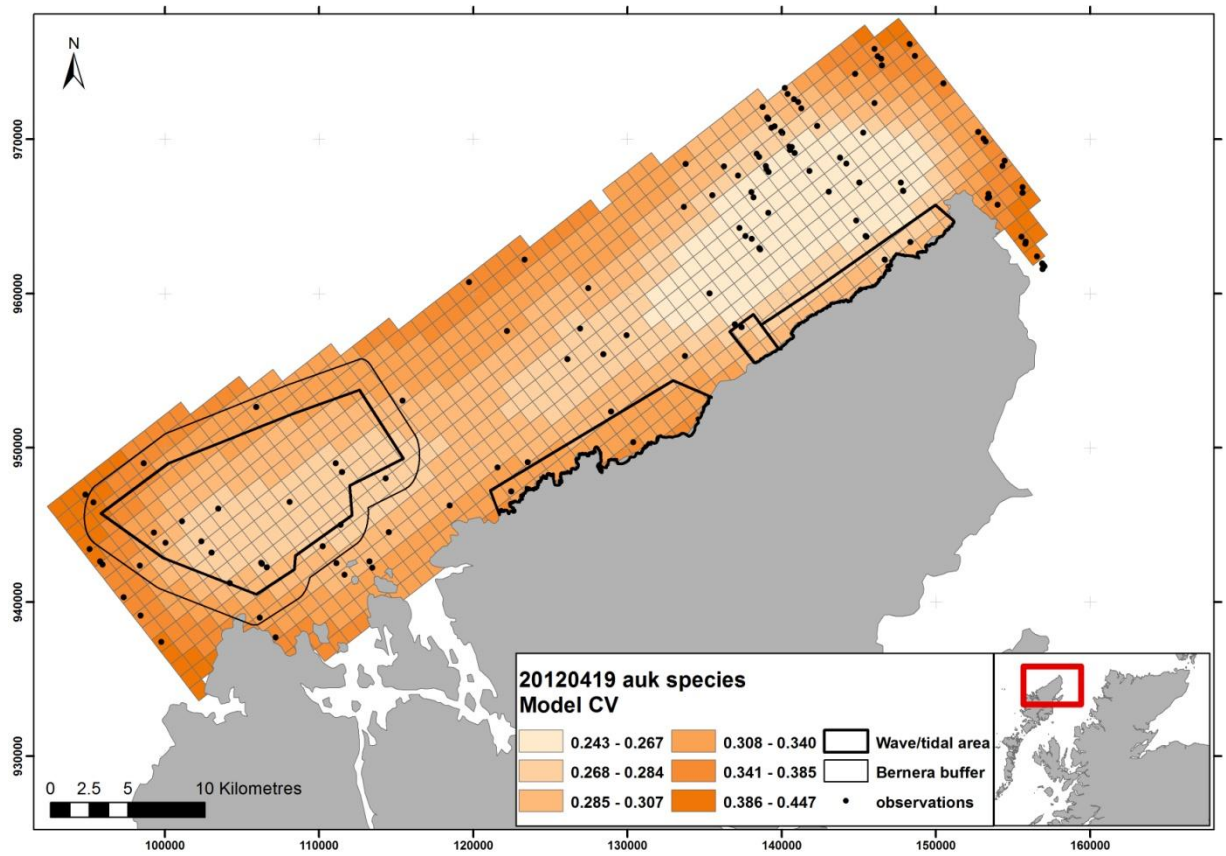


Figure 102 – May fulmar density surface model from digital aerial survey

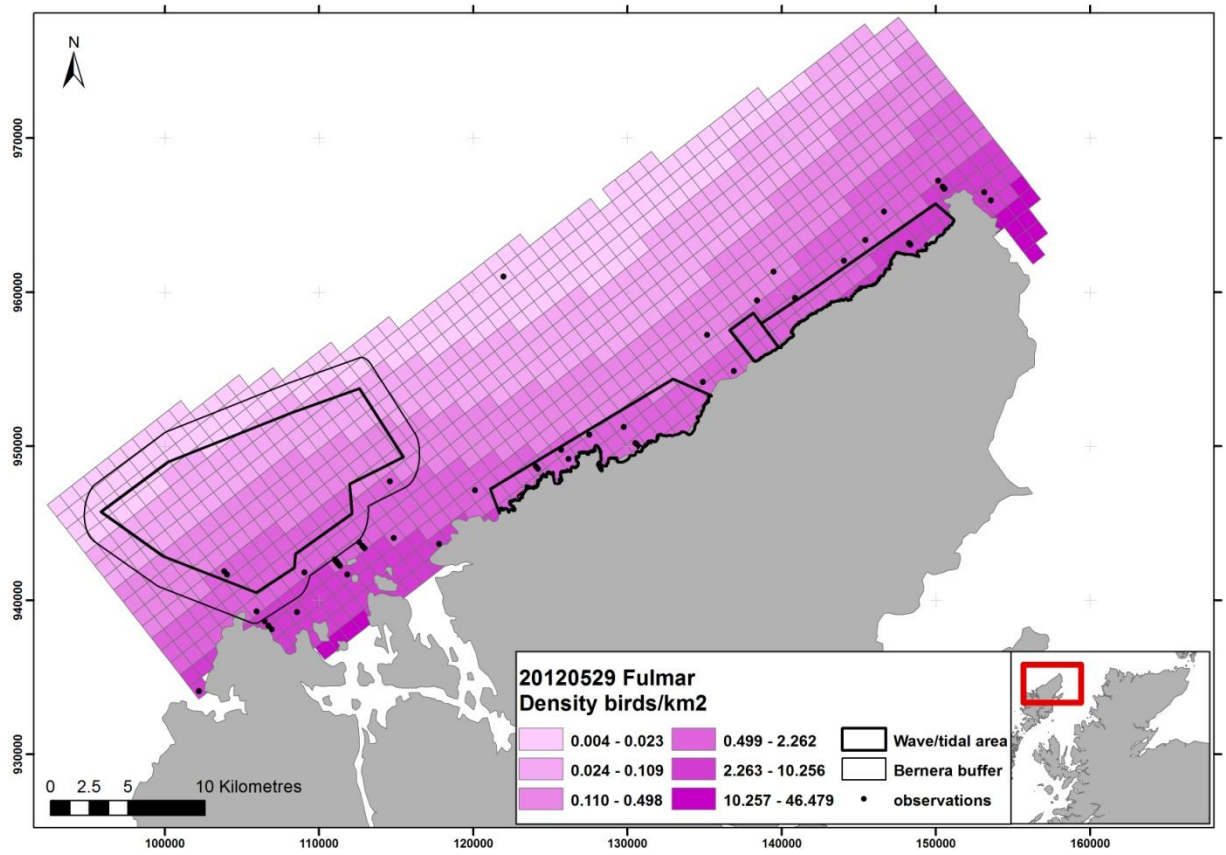


Figure 103 – May fulmar coefficient of variance map from digital aerial survey

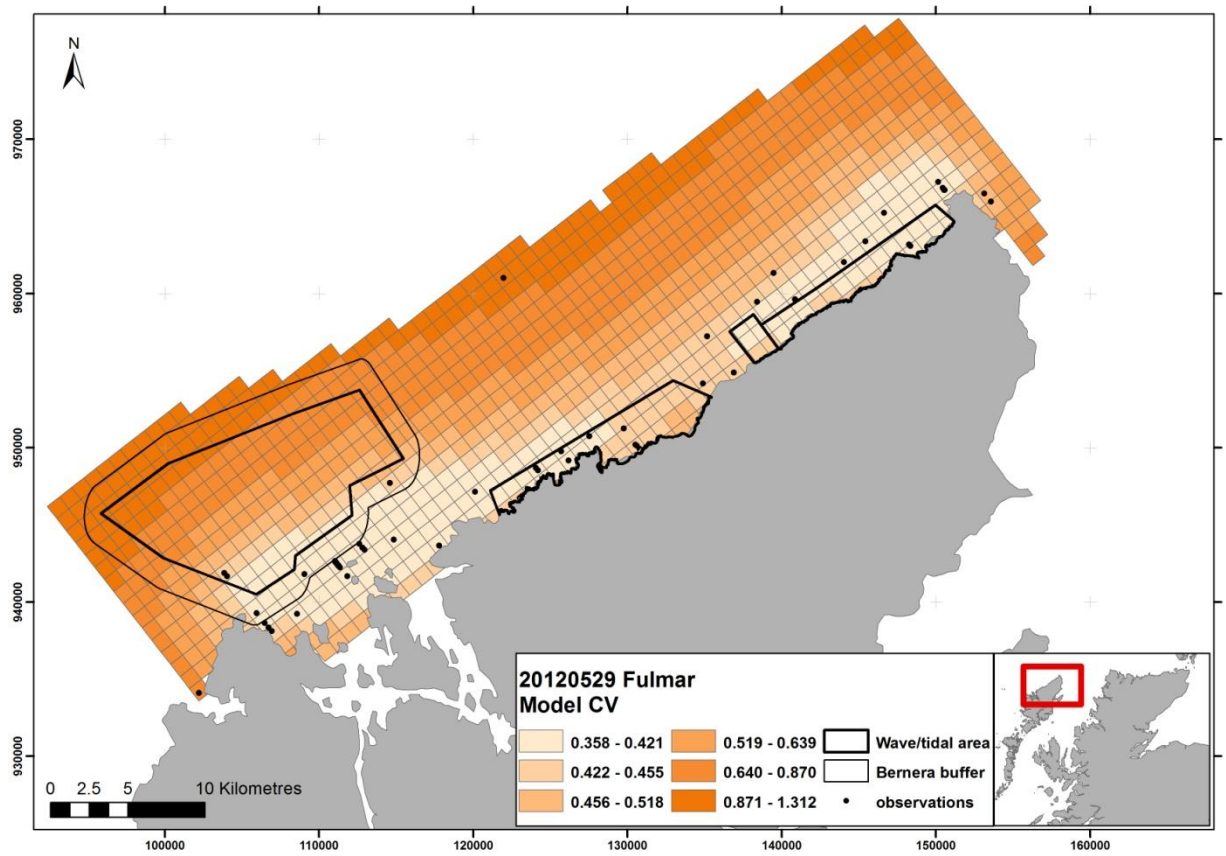


Figure 104 – May gannet density surface model from digital aerial survey

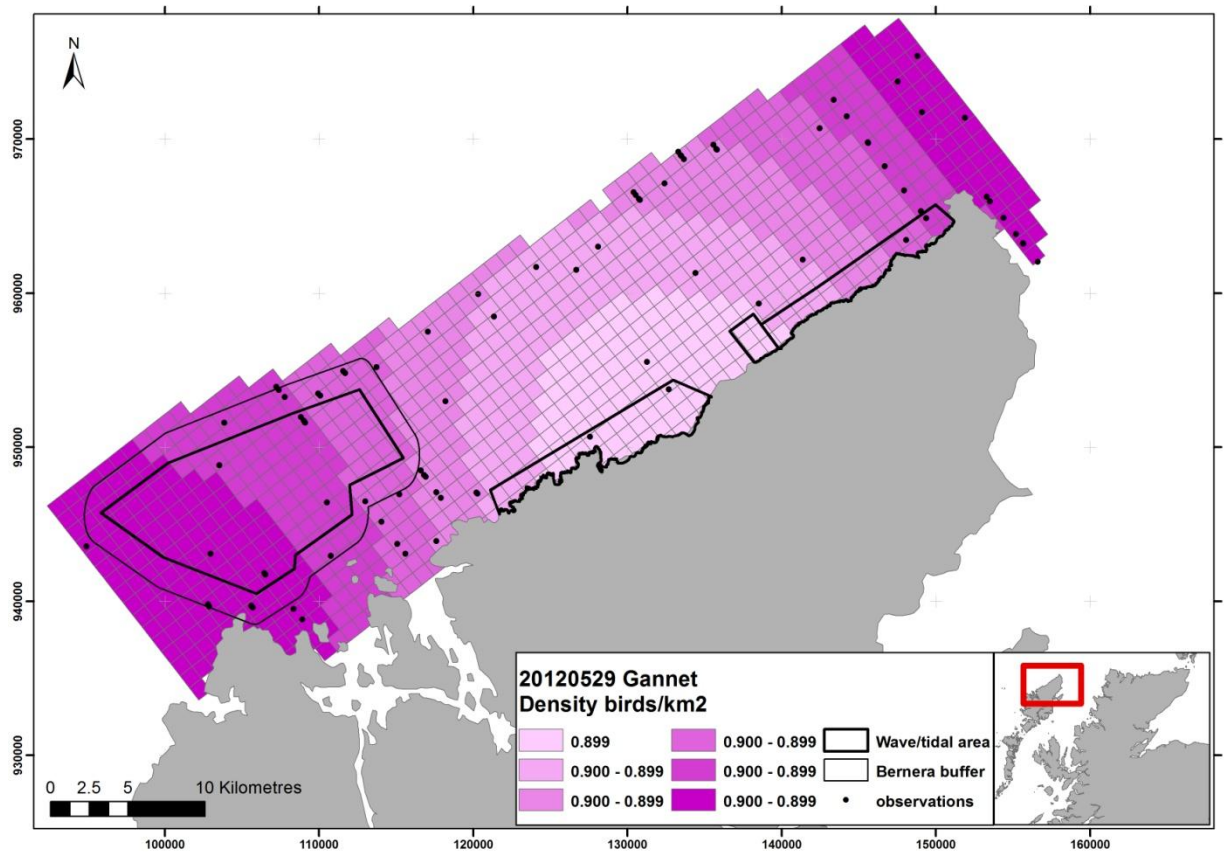


Figure 105 – May gannet coefficient of variance map from digital aerial survey

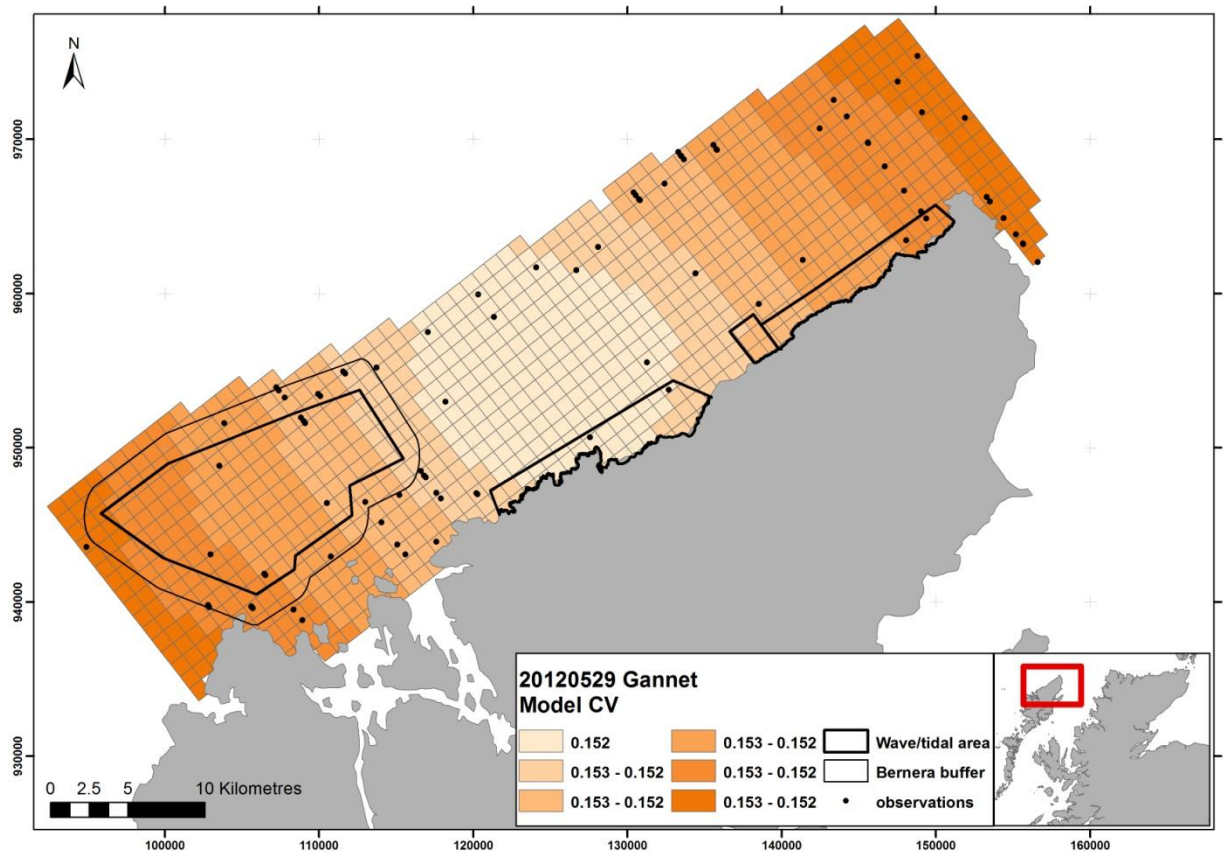


Figure 106 – May auk density surface model from digital aerial survey

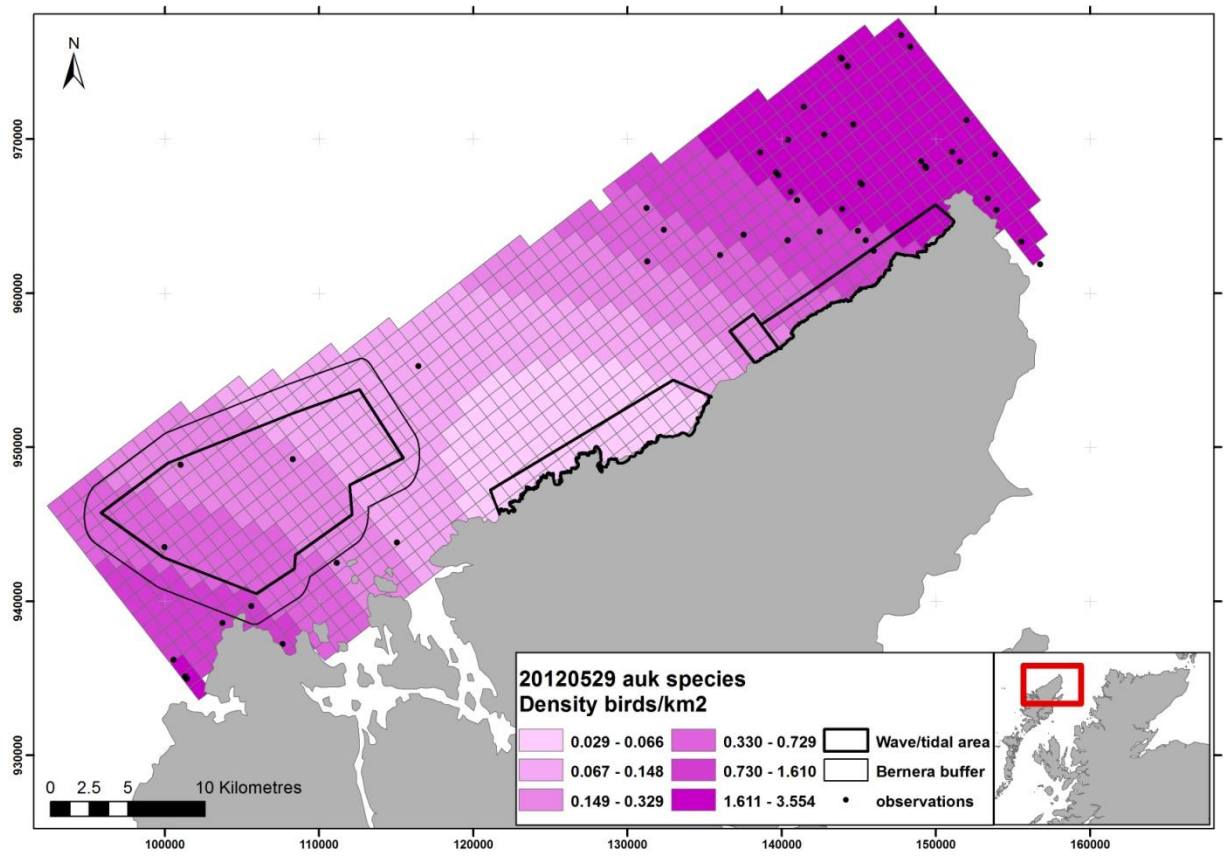


Figure 107 – May auk coefficient of variance map from digital aerial survey

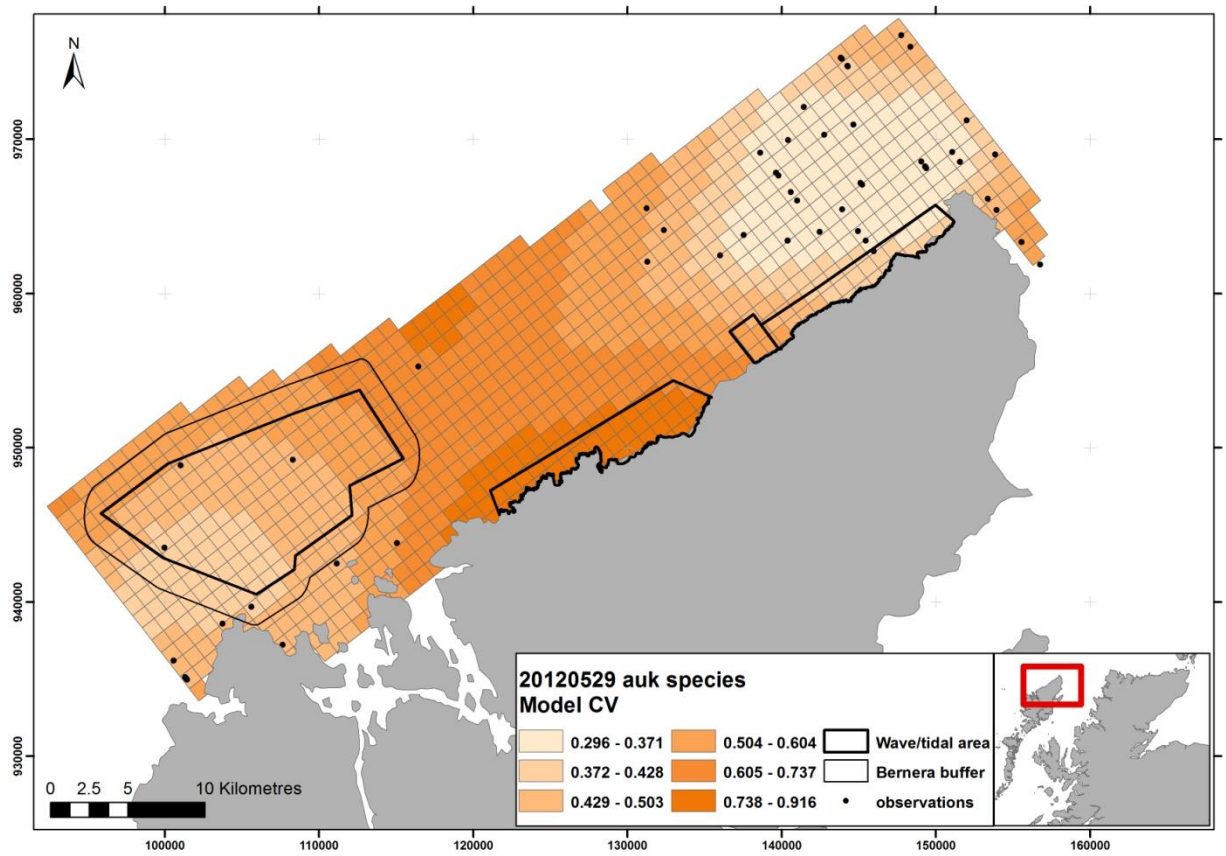


Figure 108 – June fulmar density surface model from digital aerial survey

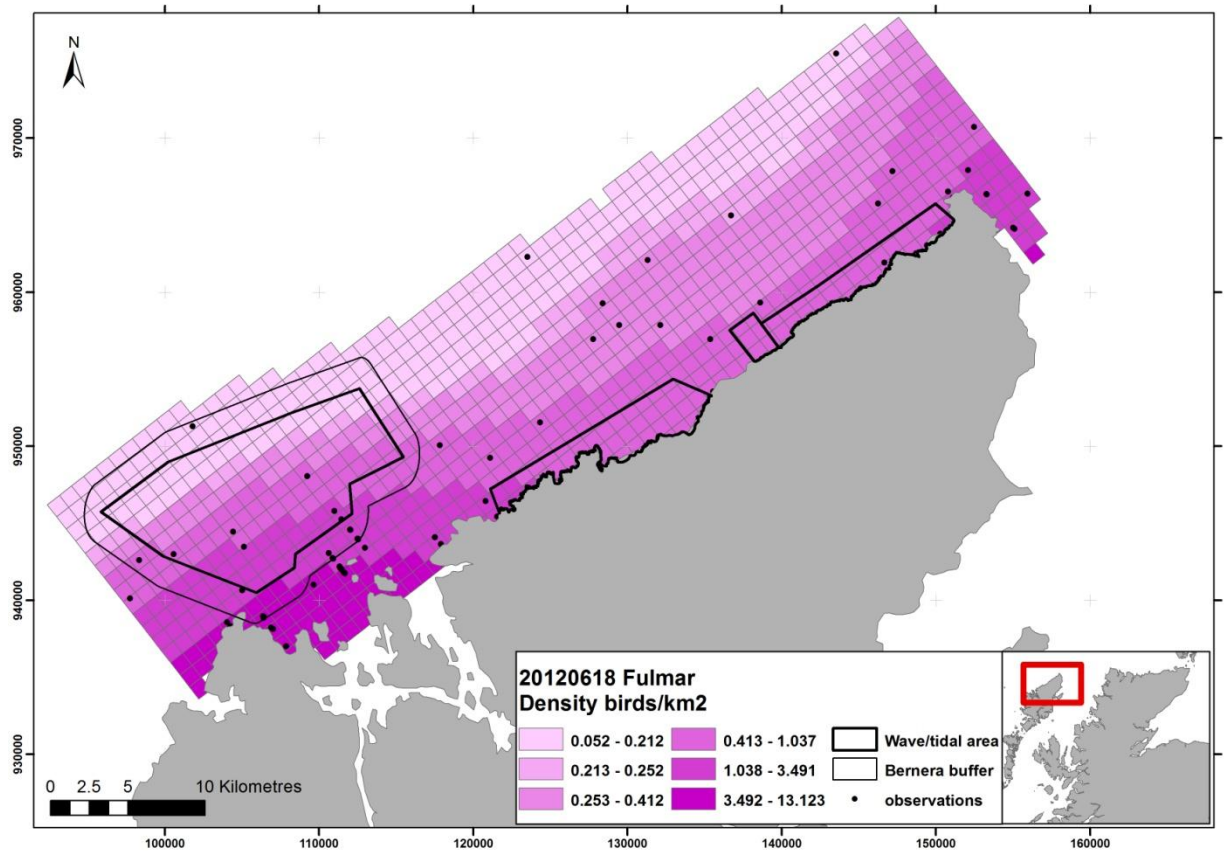


Figure 109 – June fulmar coefficient of variance map from digital aerial survey

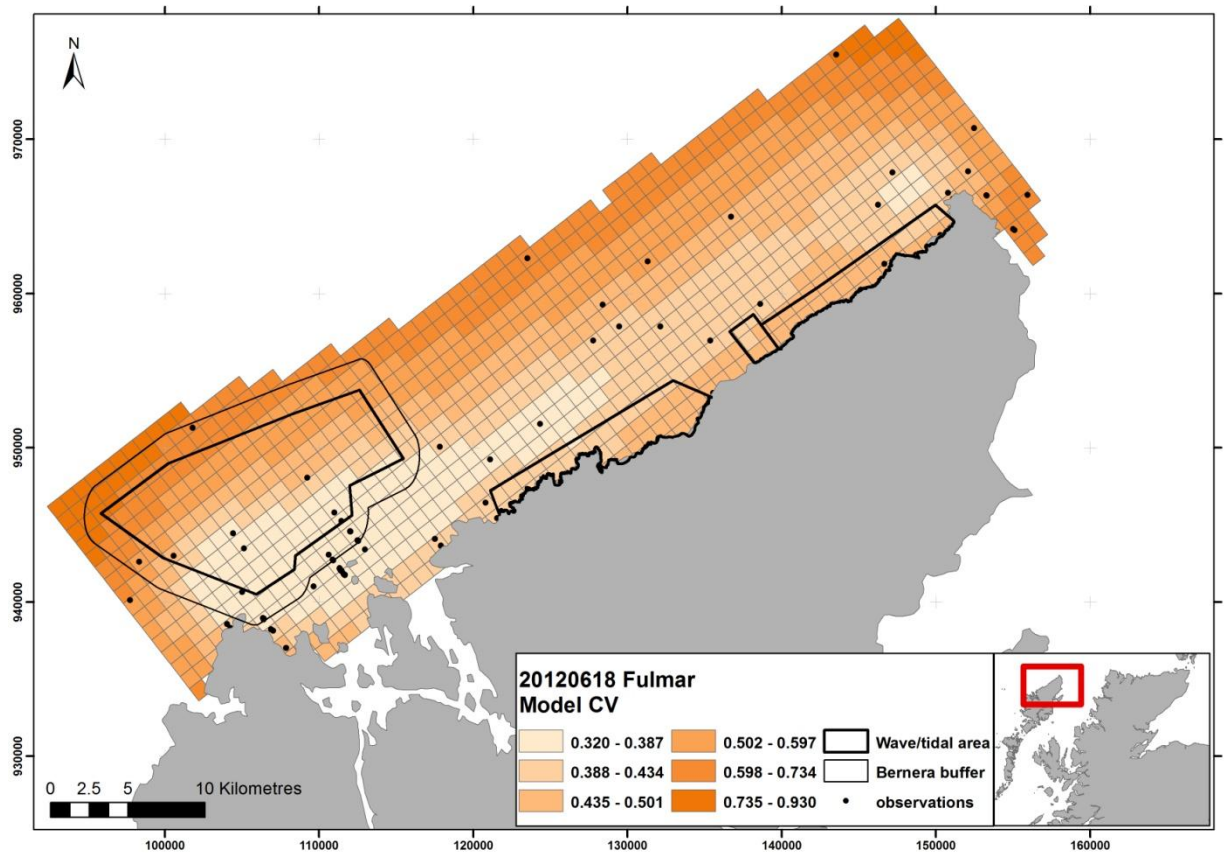


Figure 110 – June gannet density surface model from digital aerial survey

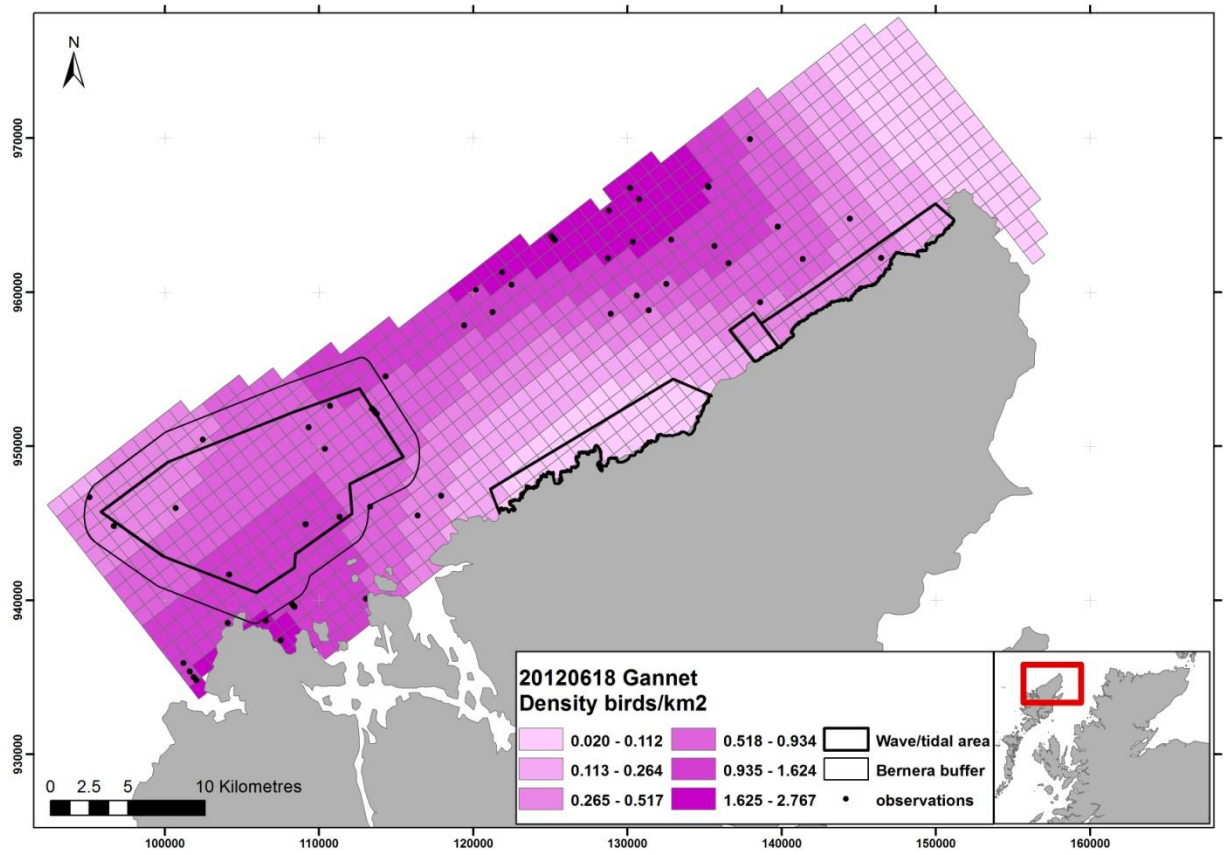


Figure 111 – June gannet coefficient of variance map from digital aerial survey

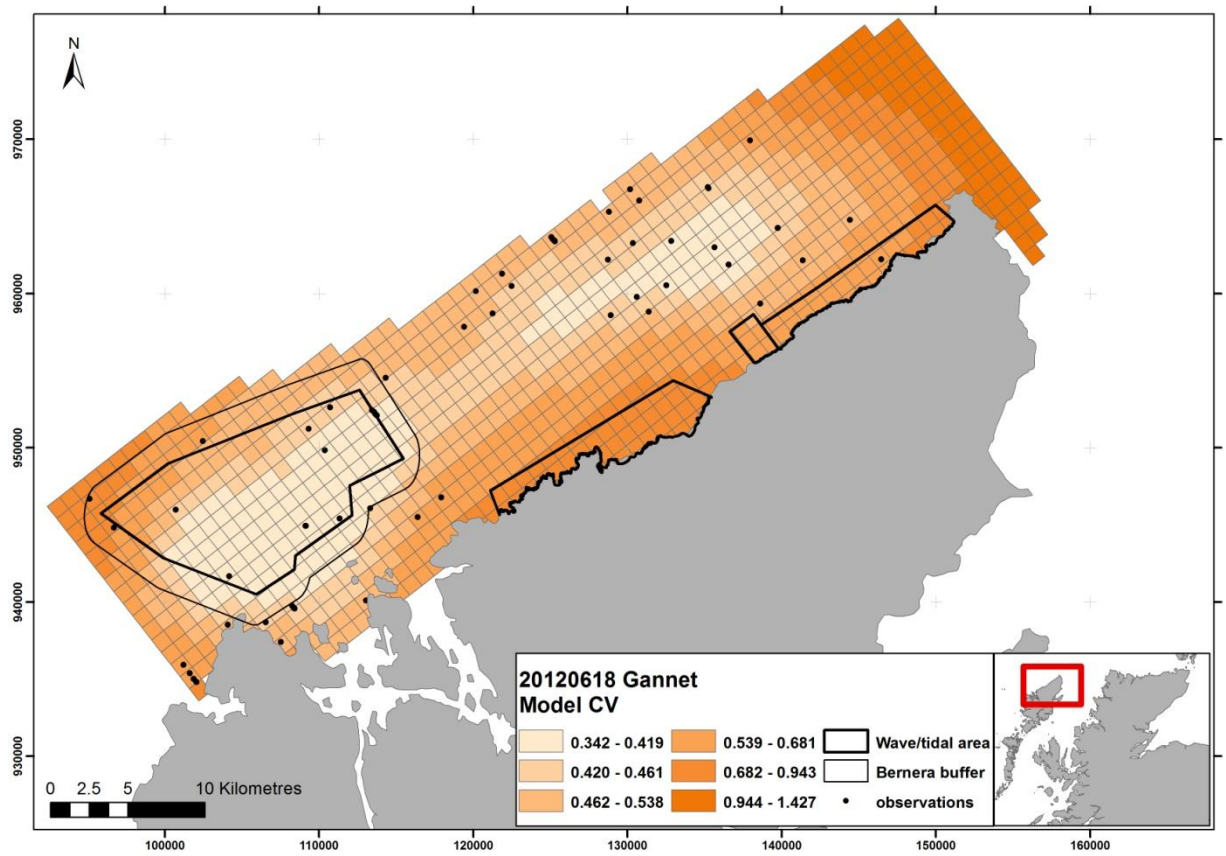


Figure 112 – June auk density surface model from digital aerial survey

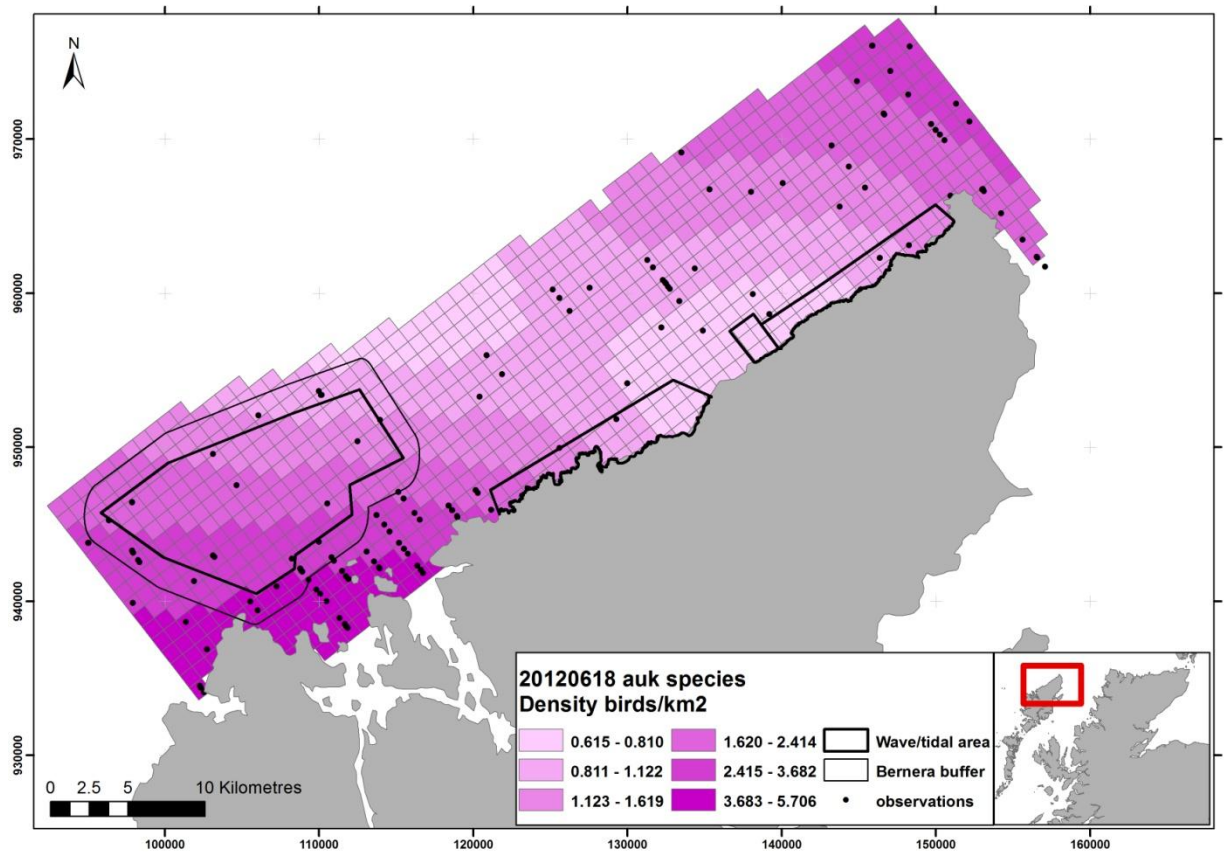


Figure 113 – June auk coefficient of variance map from digital aerial survey

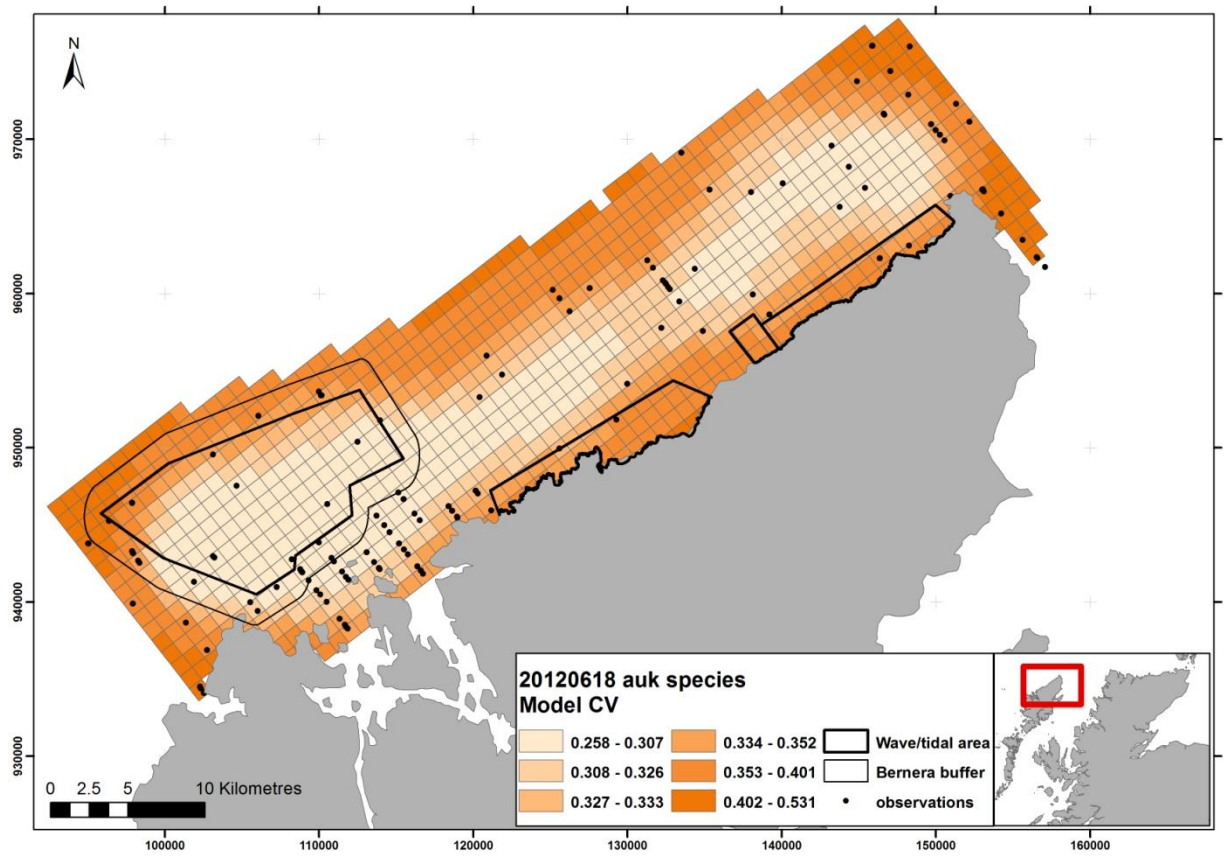


Figure 114 – July fulmar density surface model from digital aerial survey

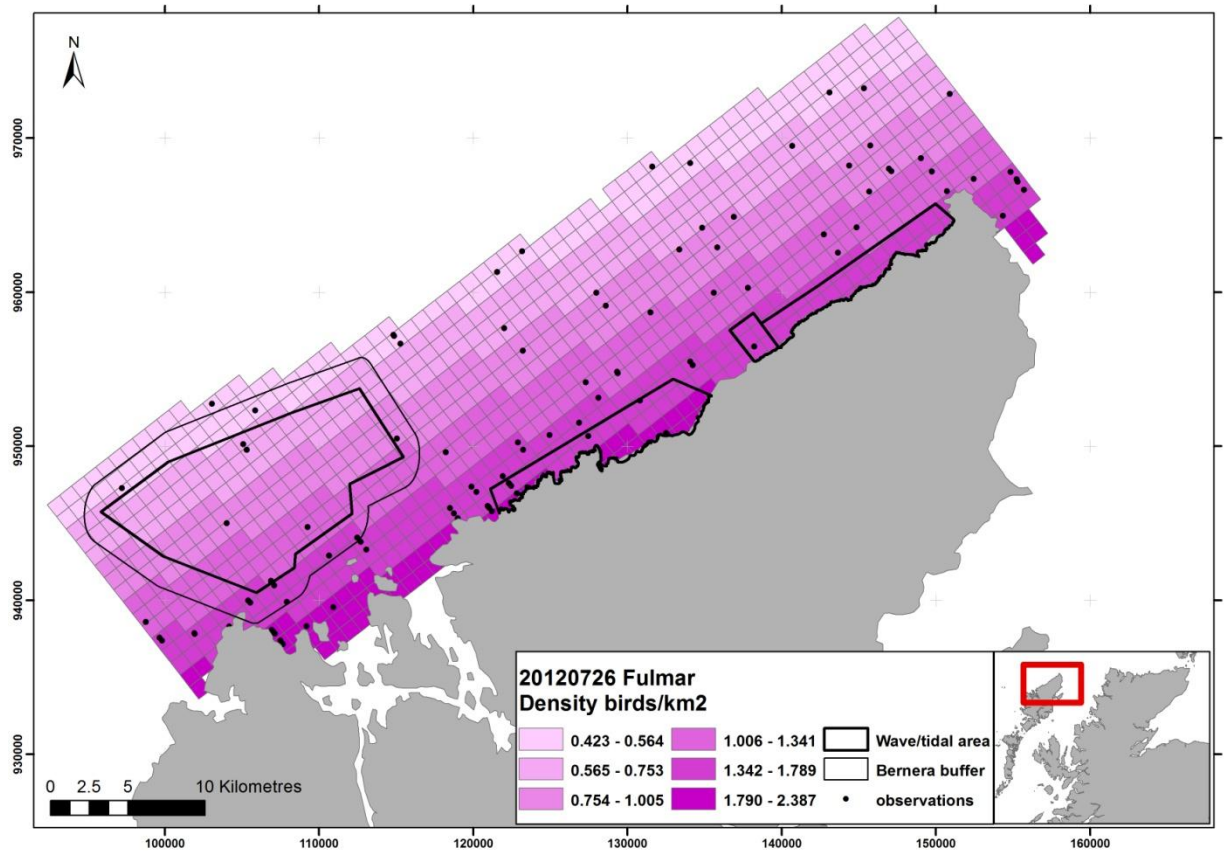


Figure 115 – July fulmar coefficient of variance map from digital aerial survey

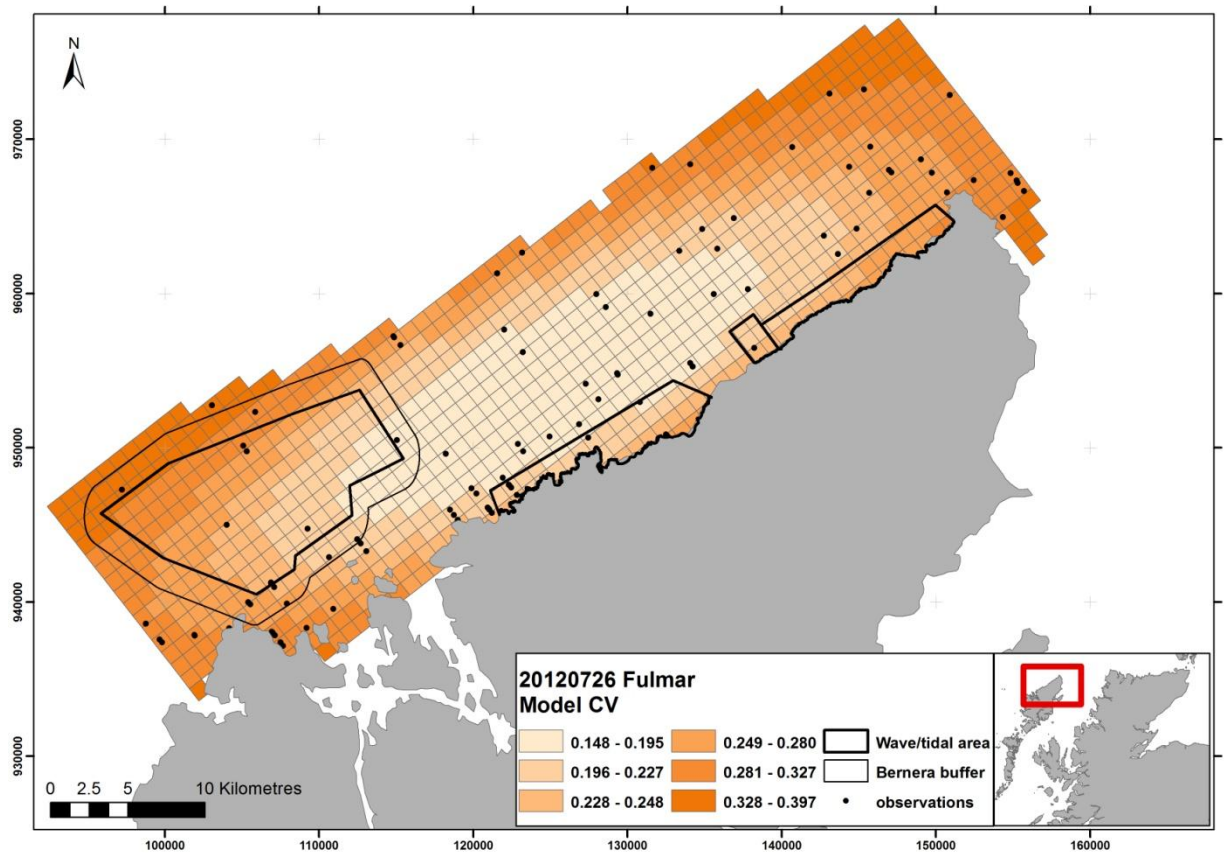


Figure 116 – July gannet density surface model from digital aerial survey

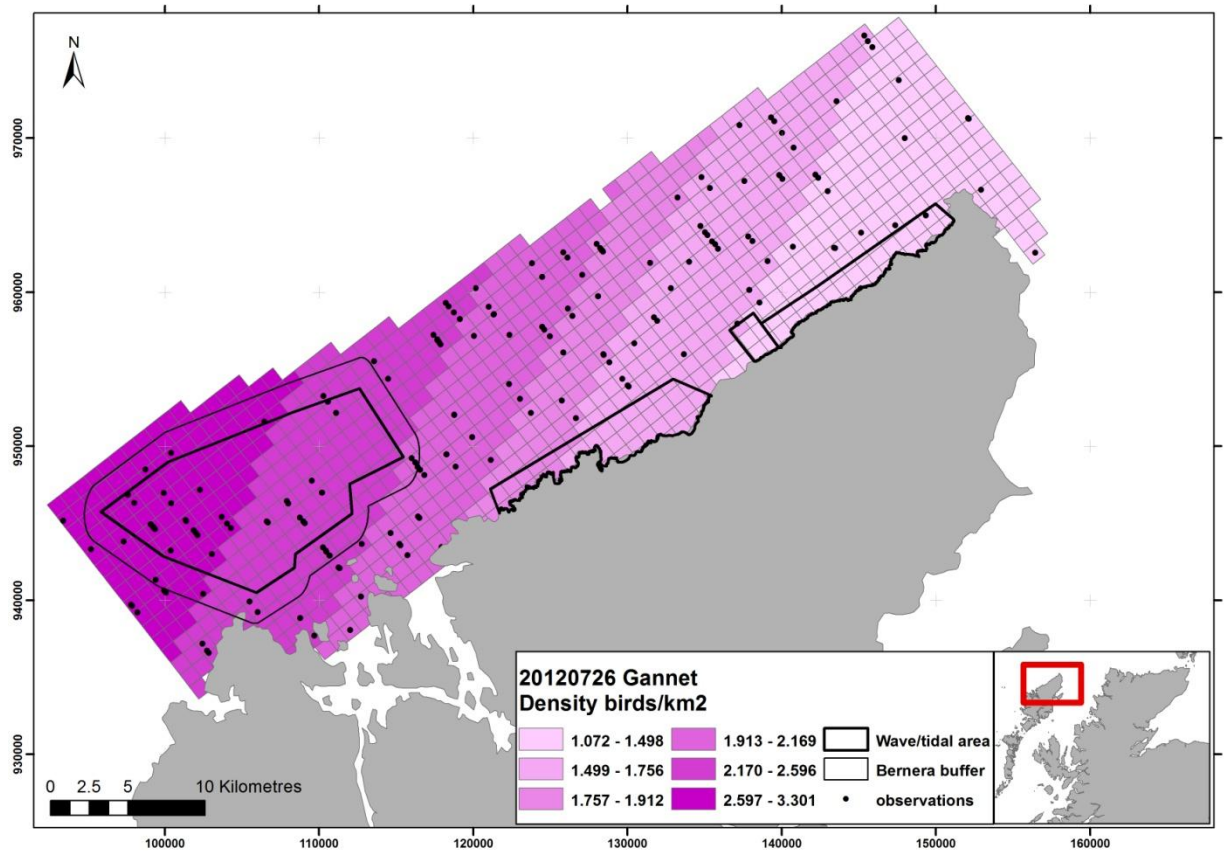


Figure 117 – July gannet coefficient of variance map from digital aerial survey

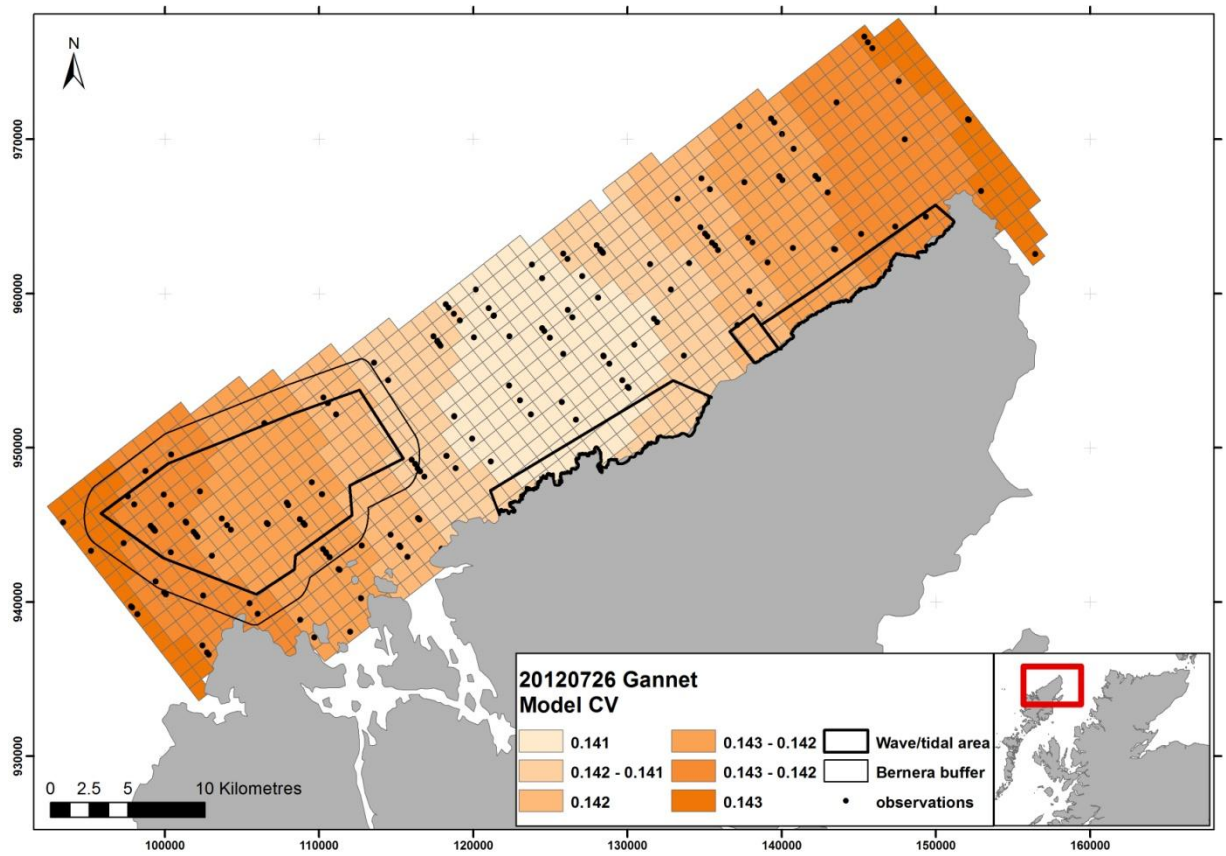


Figure 118 – July auk density surface model from digital aerial survey

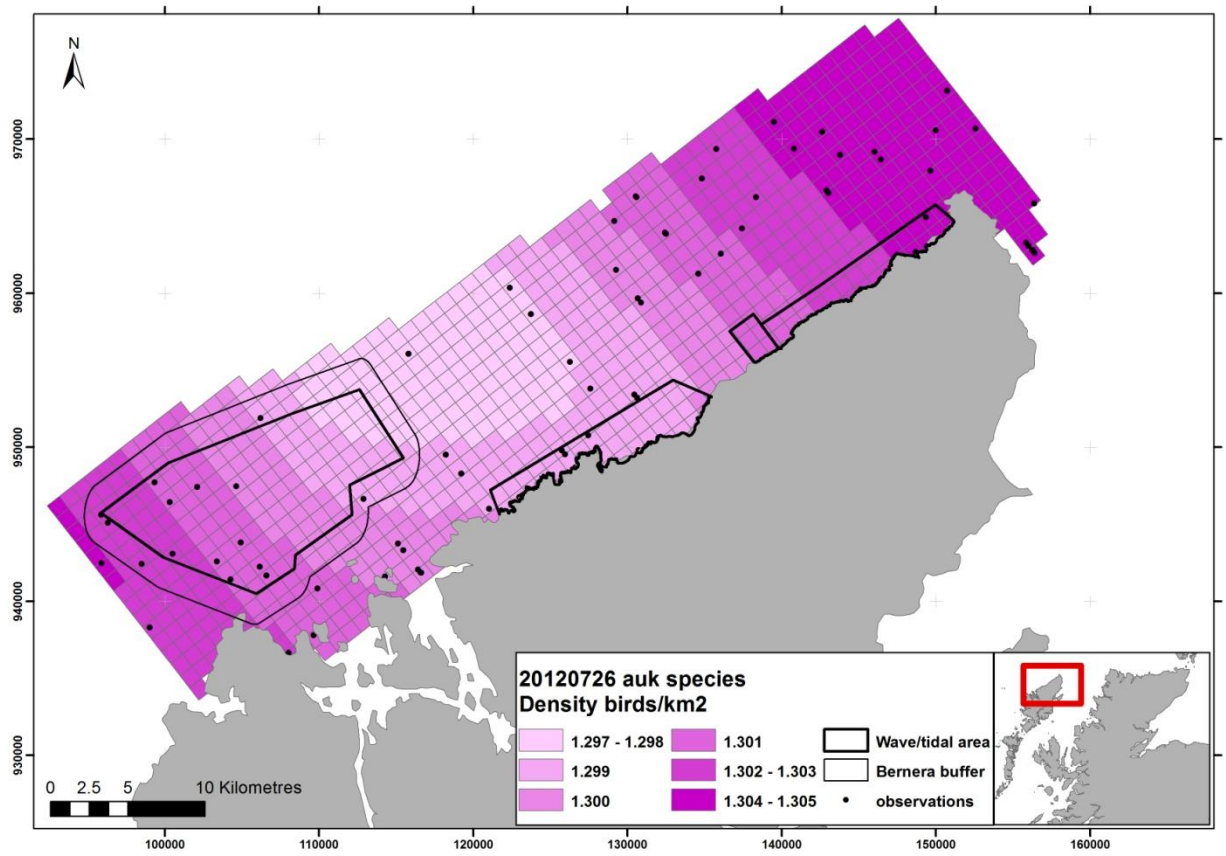


Figure 119 – July auk coefficient of variance map from digital aerial survey

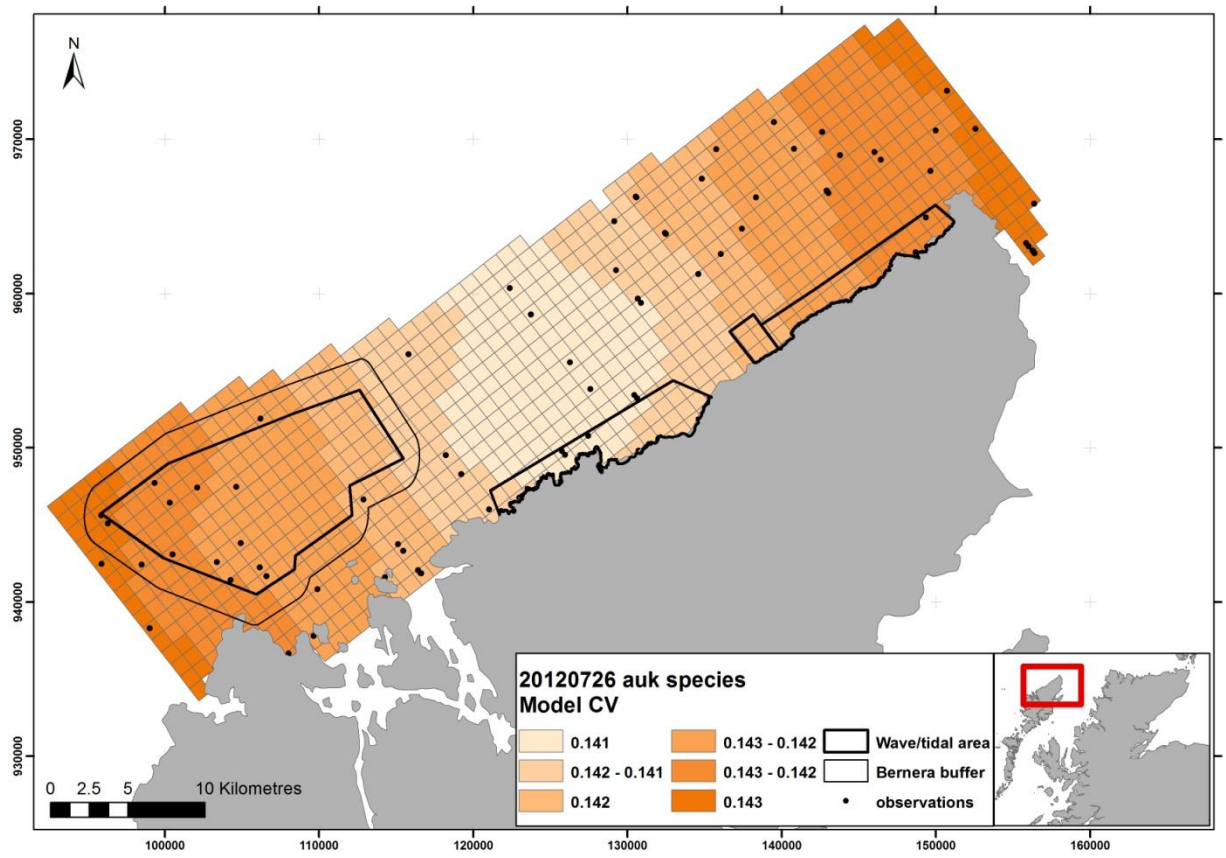


Figure 120 - September fulmar density surface model from digital aerial survey

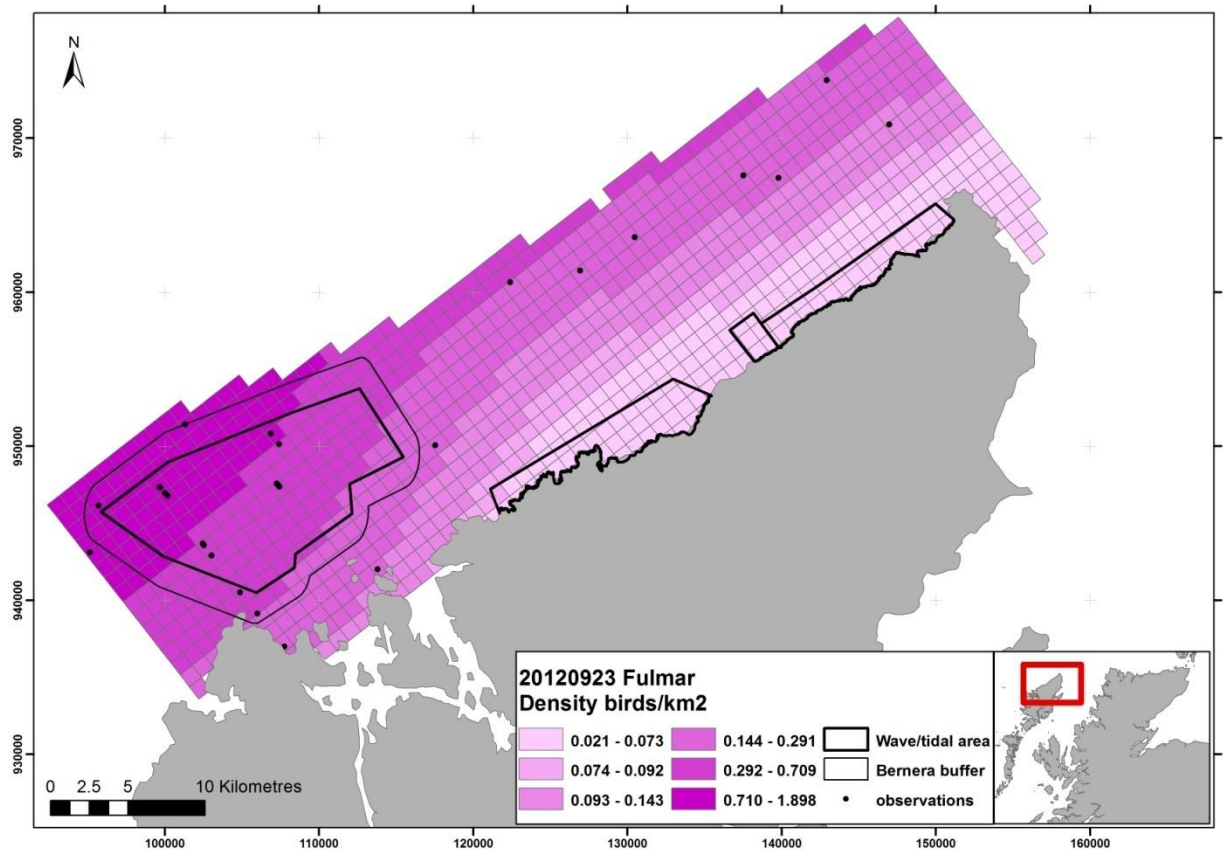


Figure 121 - September fulmar coefficient of variance map from digital aerial survey

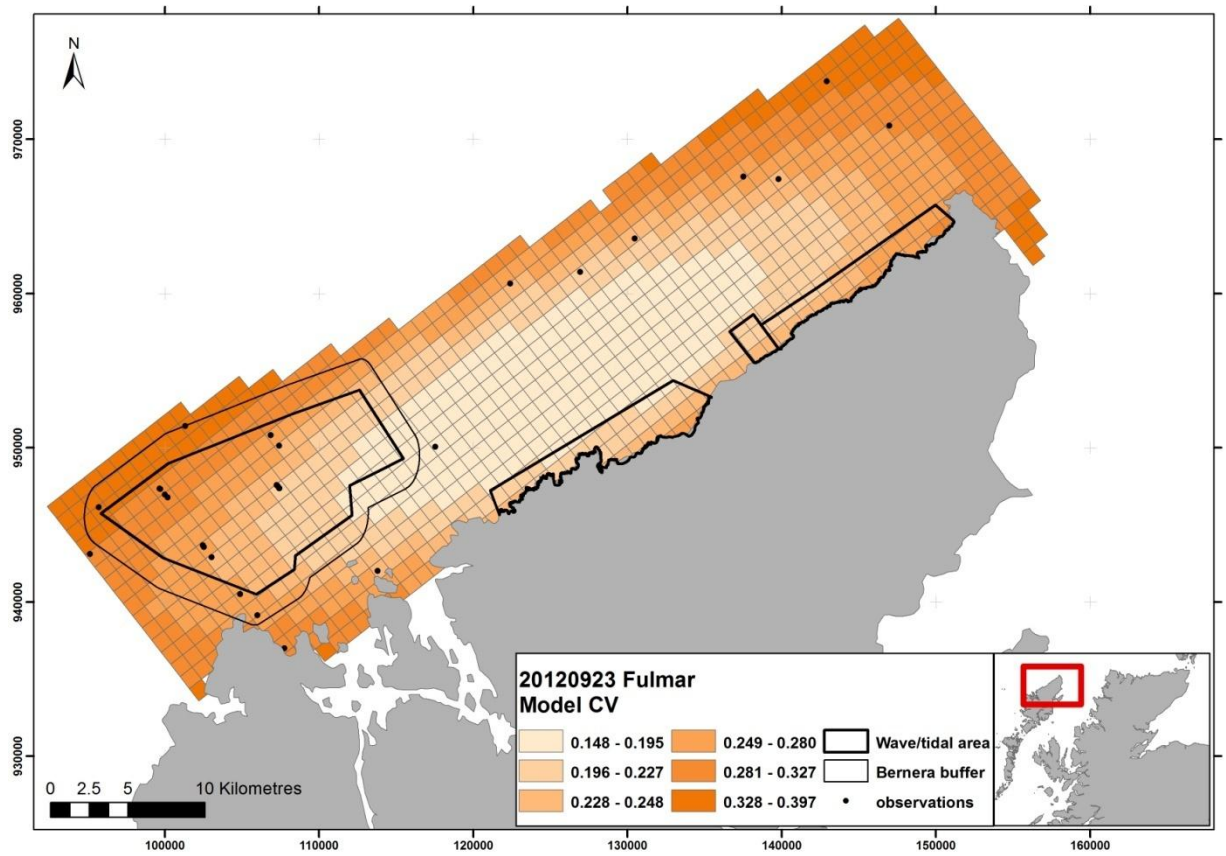


Figure 122 - September gannet density surface model from digital aerial survey

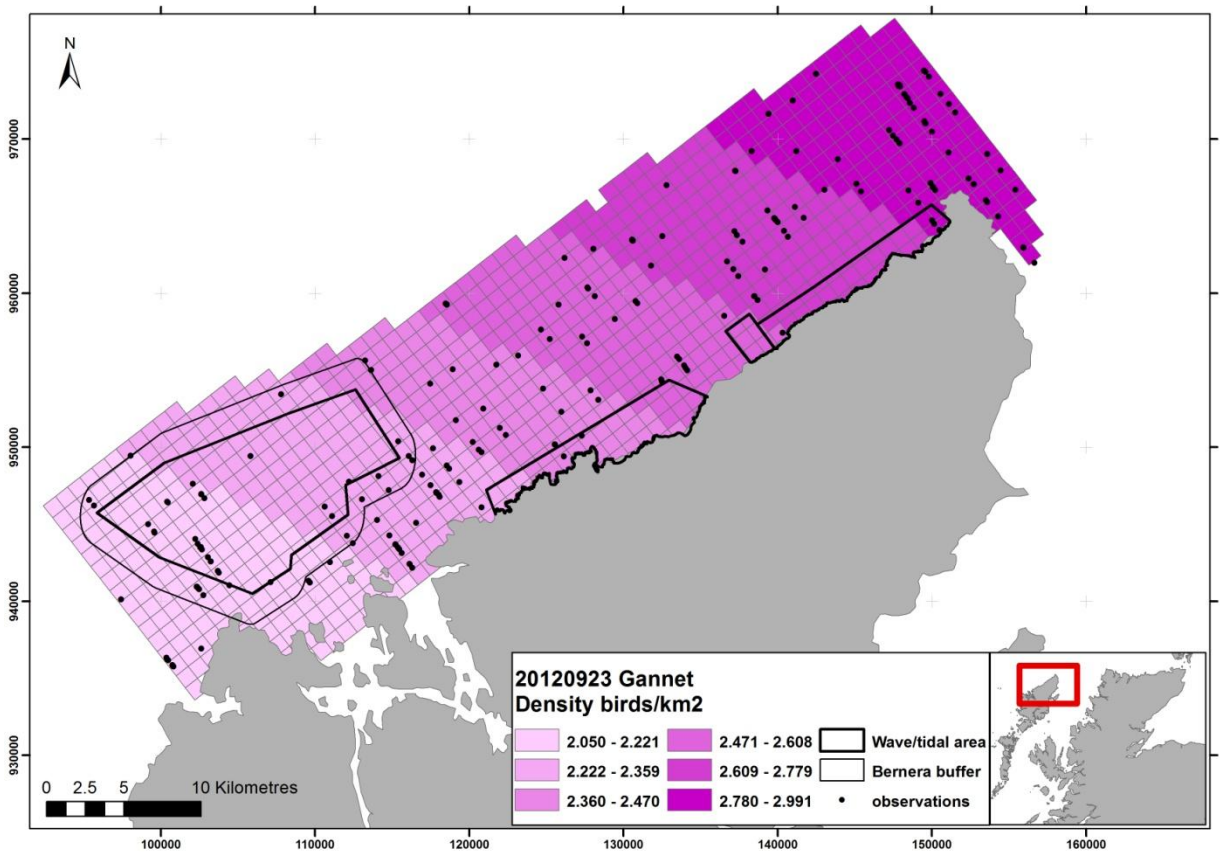


Figure 123 - September gannet coefficient of variance map from digital aerial survey

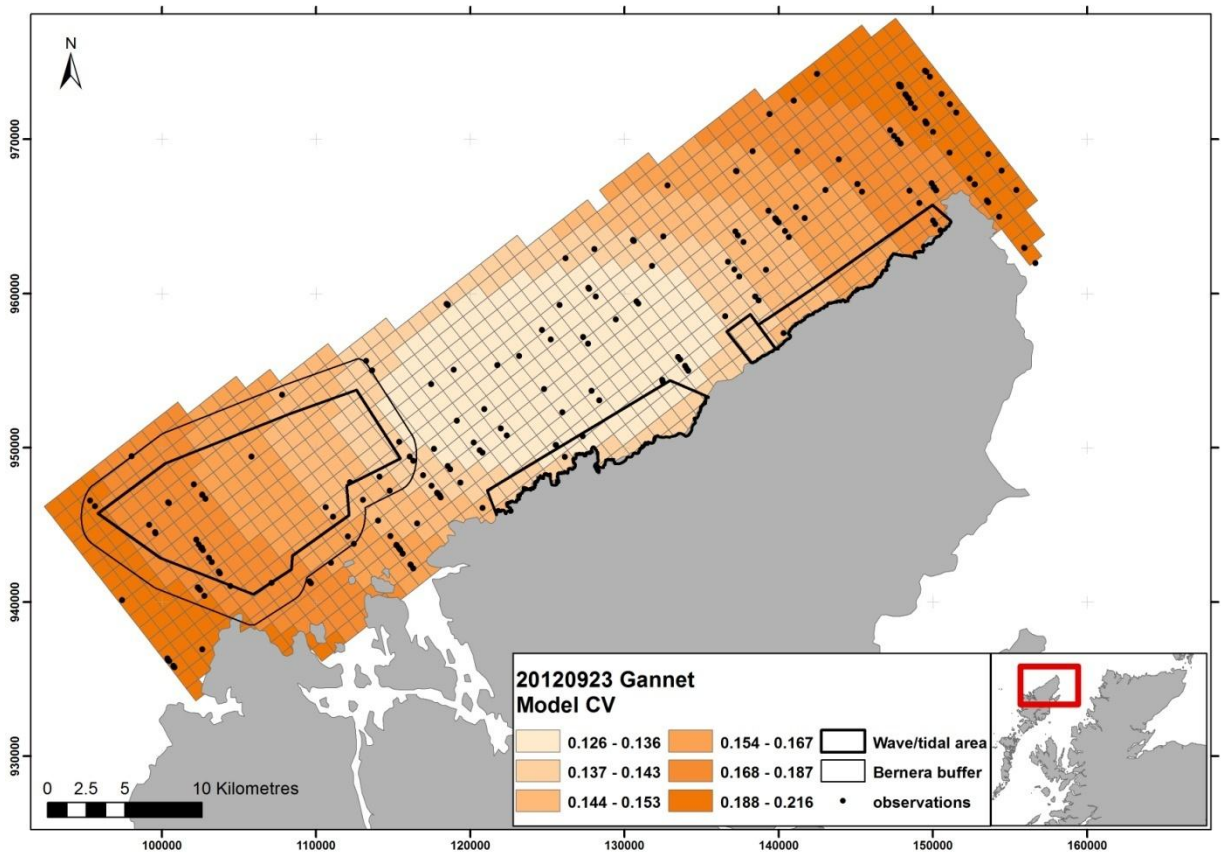


Figure 124 - September auk density surface model from digital aerial survey

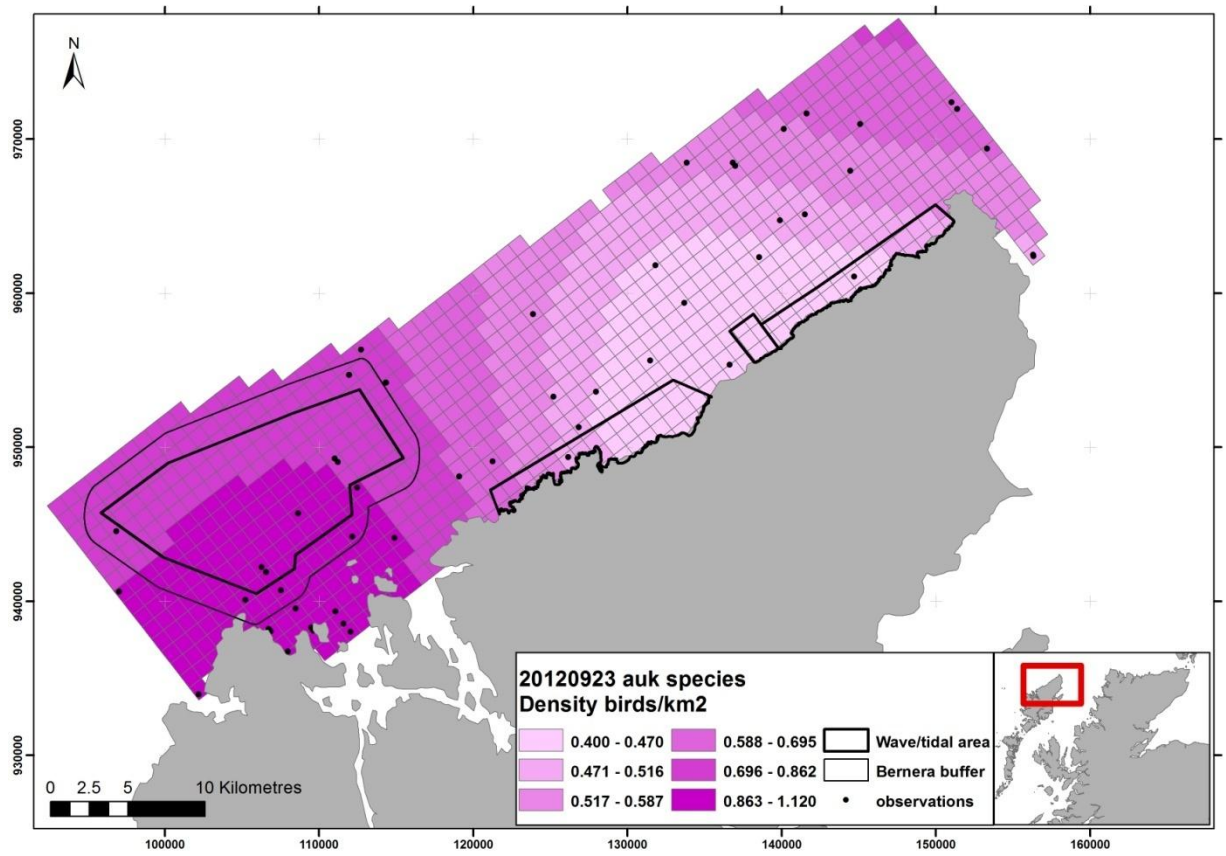


Figure 125 - September auk coefficient of variance map from digital aerial survey

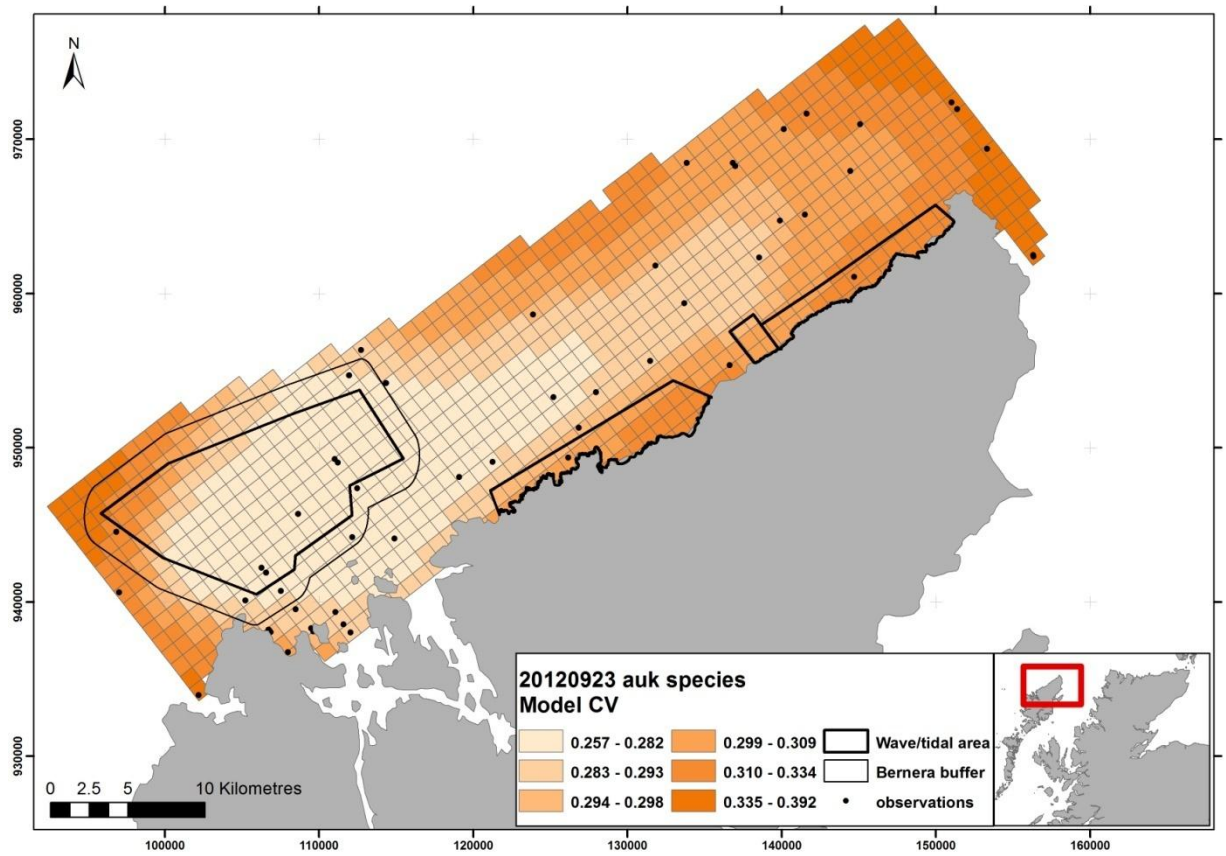


Figure 126 – December fulmar density surface model from digital aerial survey

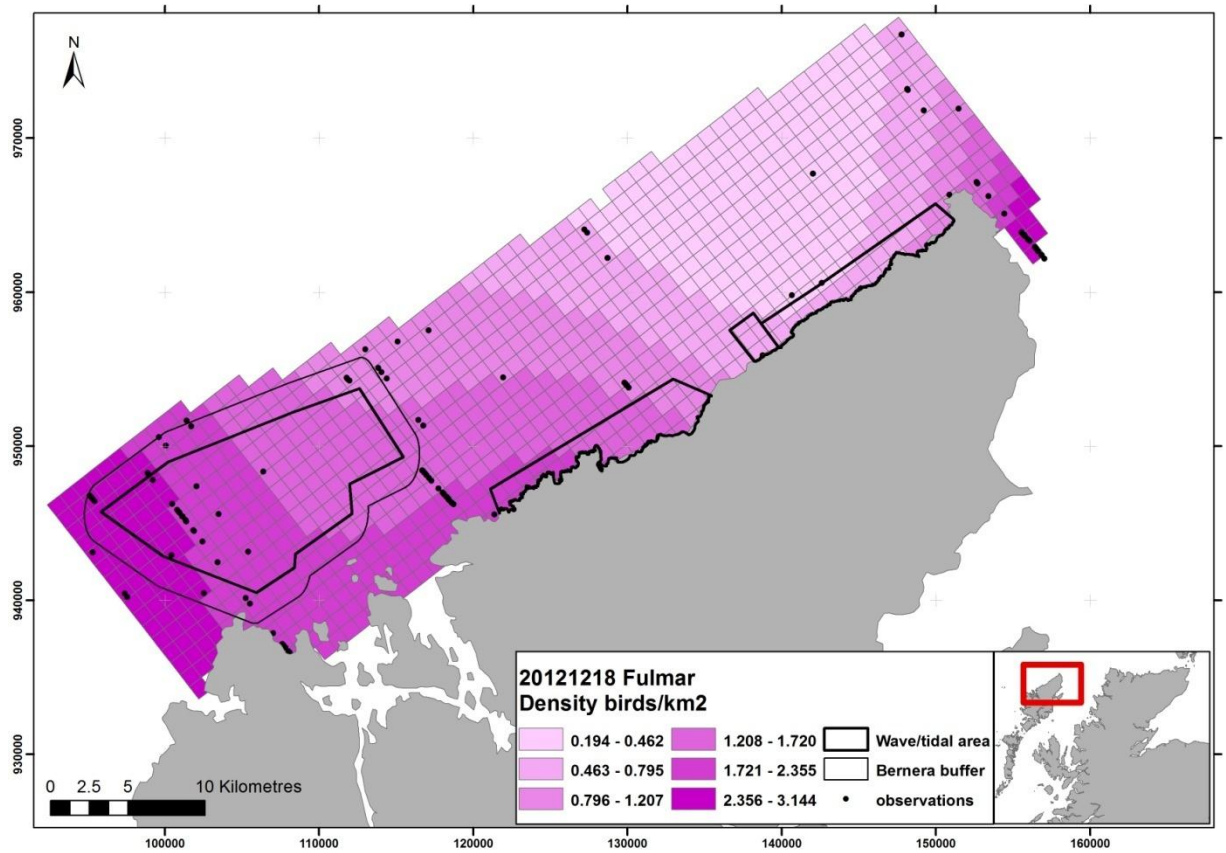


Figure 127 - December fulmar coefficient of variance map from digital aerial survey

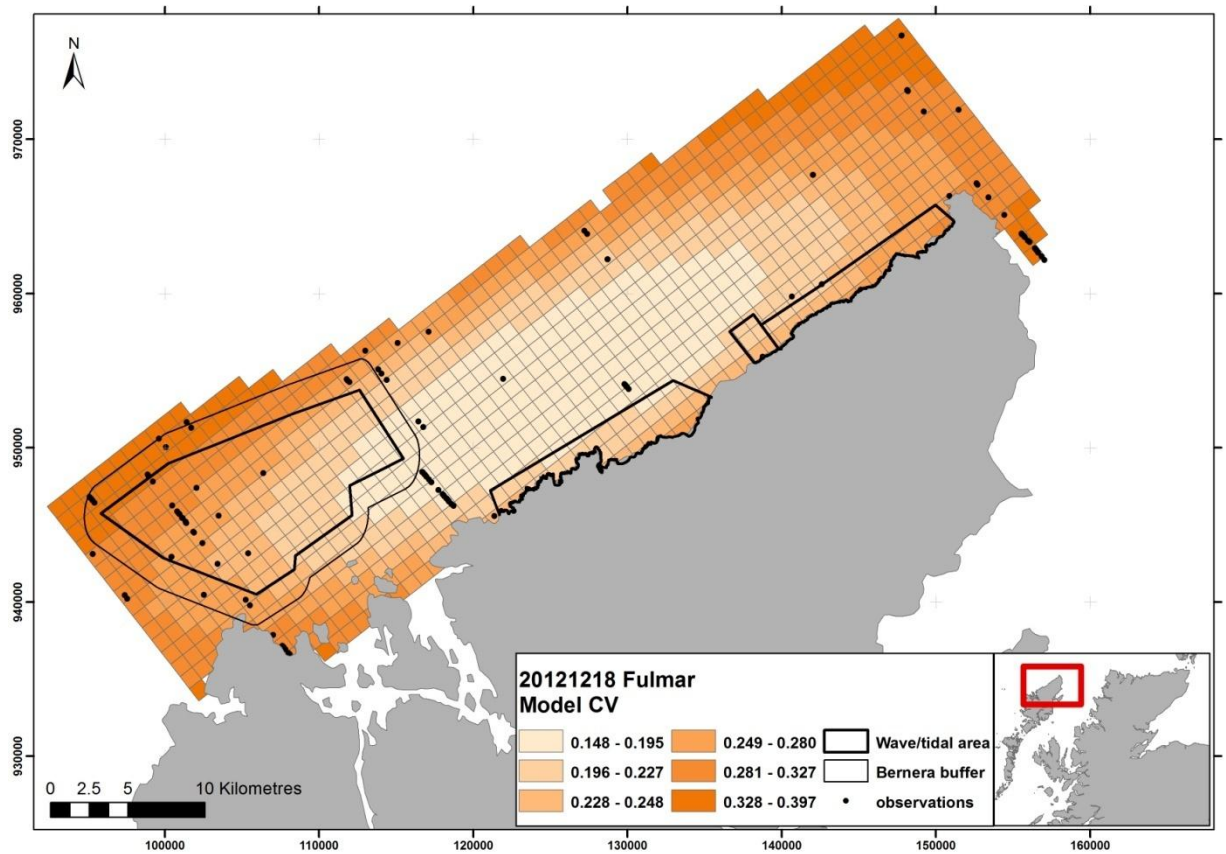


Figure 128 - December gannet density surface model from digital aerial survey

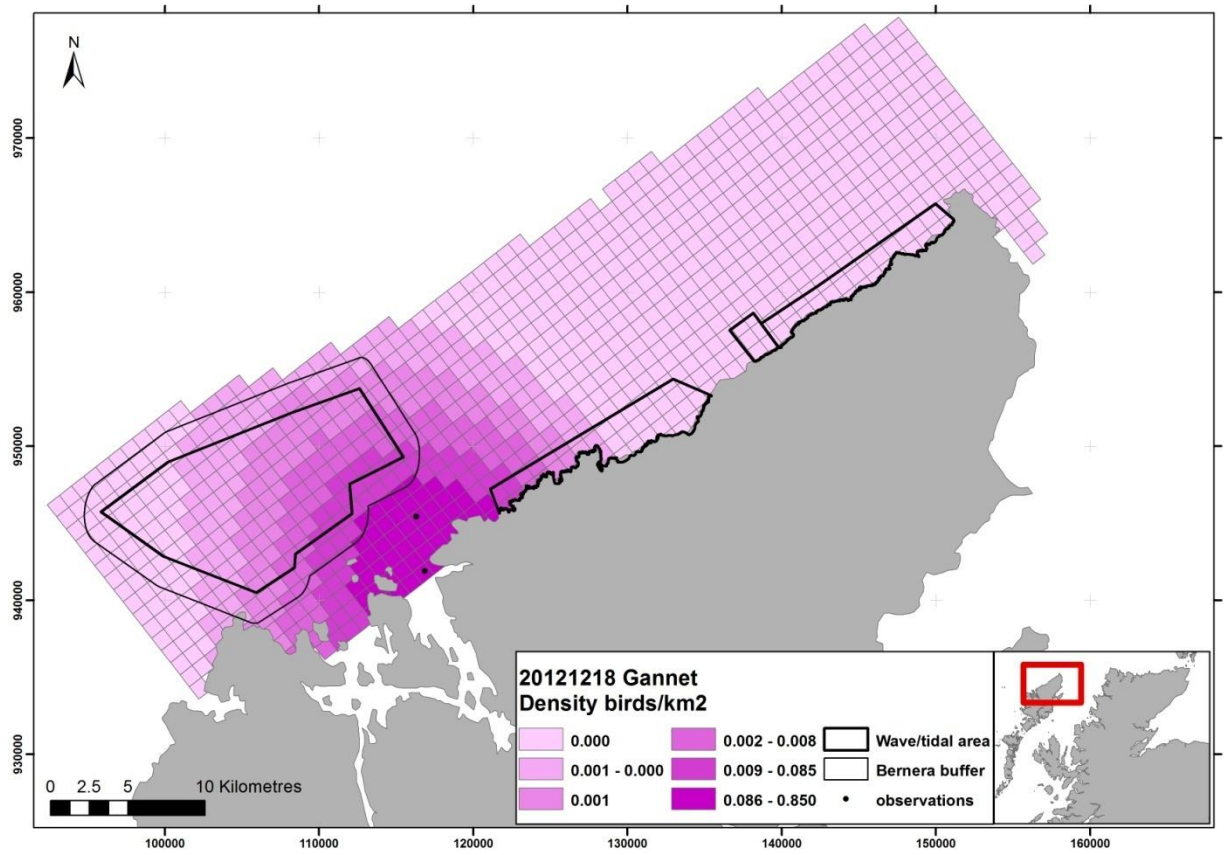


Figure 129 - December gannet coefficient of variance map from digital aerial survey

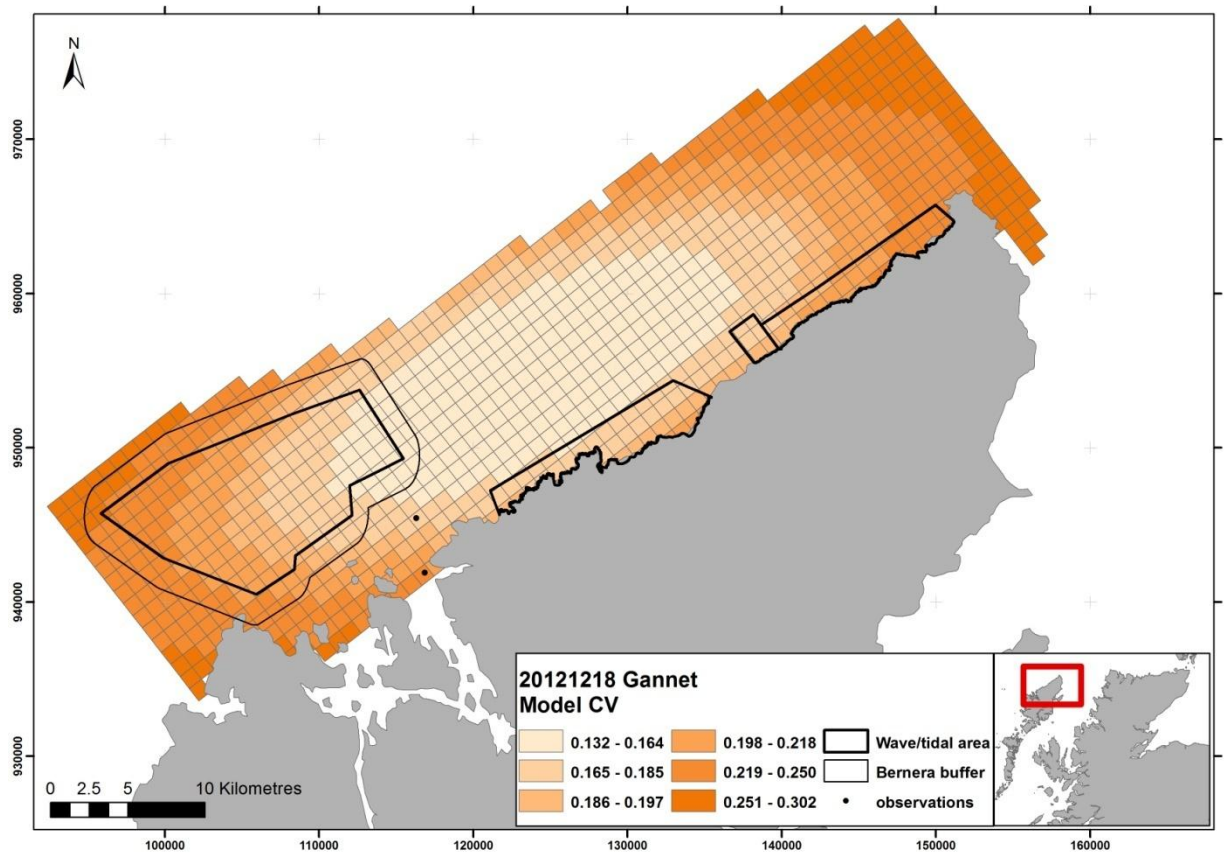


Figure 130 - December auk density surface model from digital aerial survey

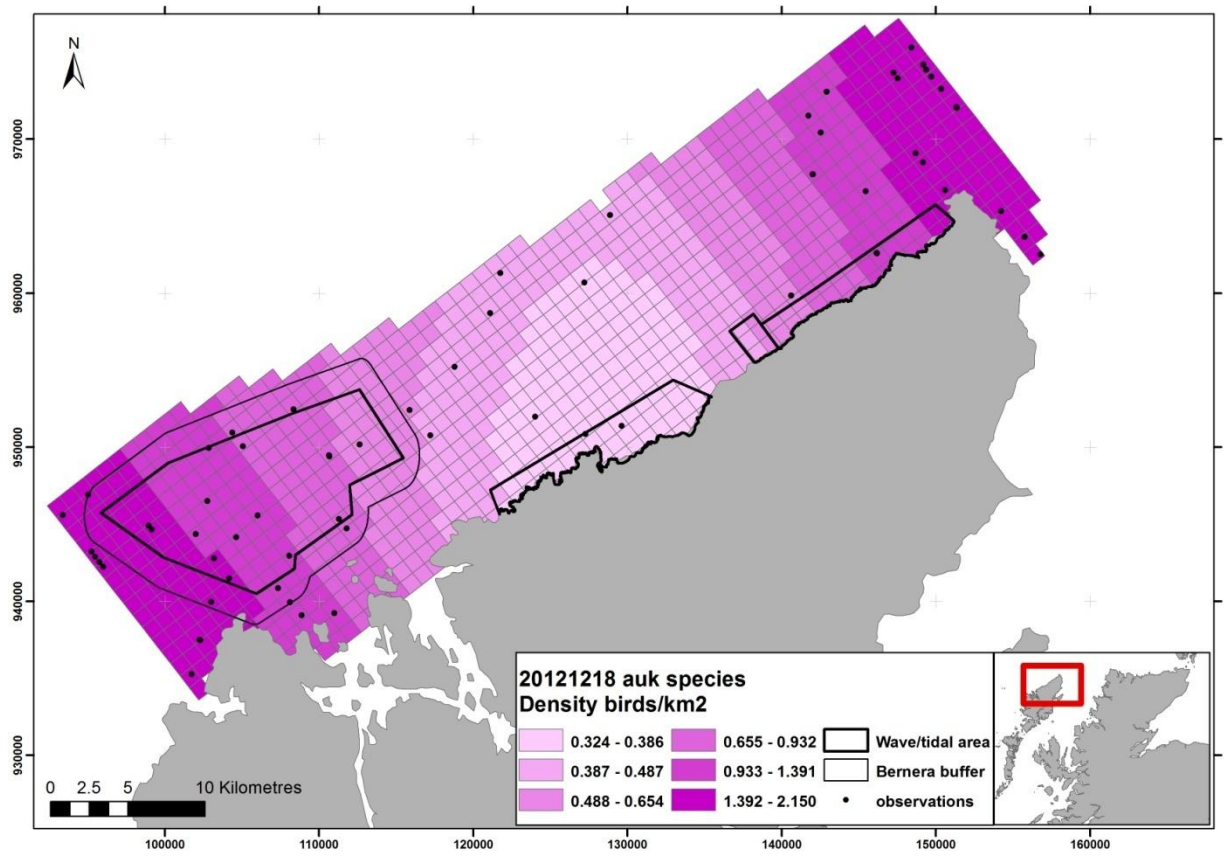


Figure 131 - December auk coefficient of variance map from digital aerial survey

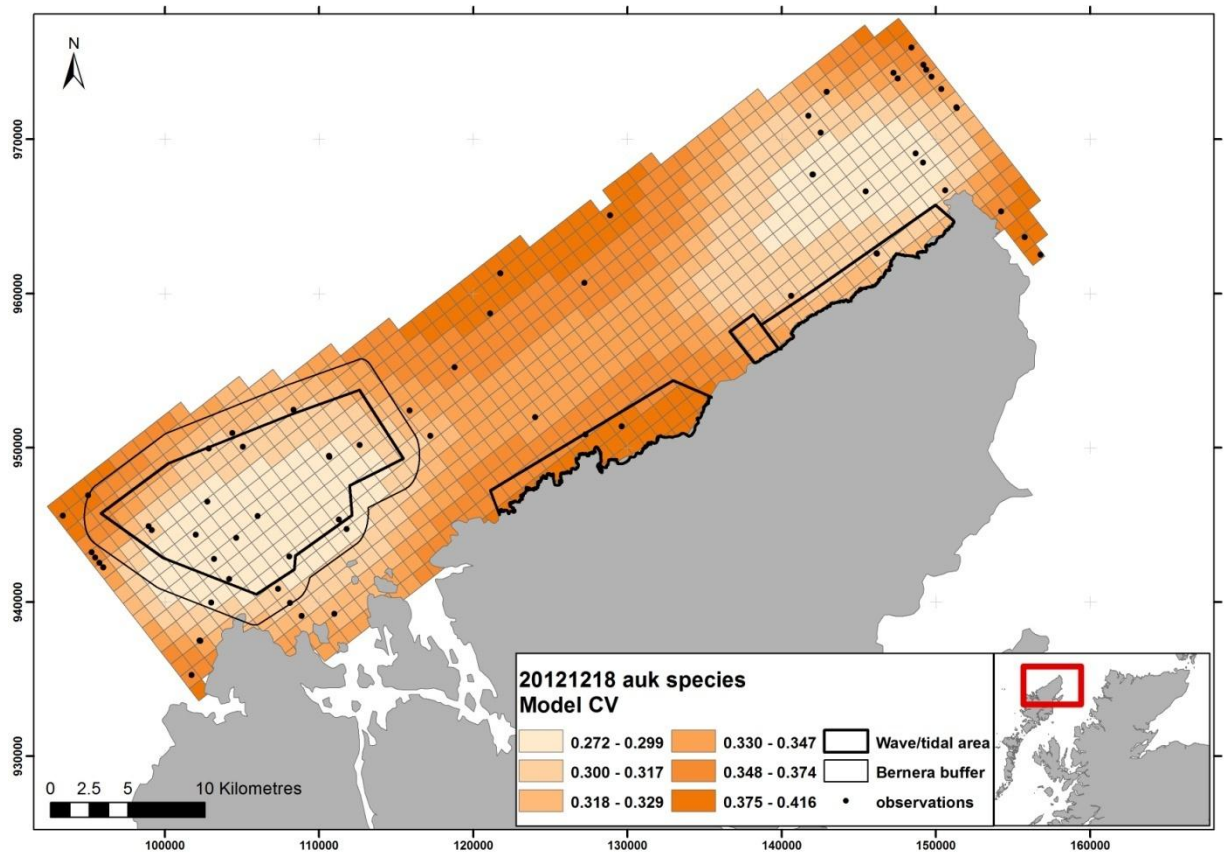


Figure 132 - February fulmar density surface model from digital aerial survey

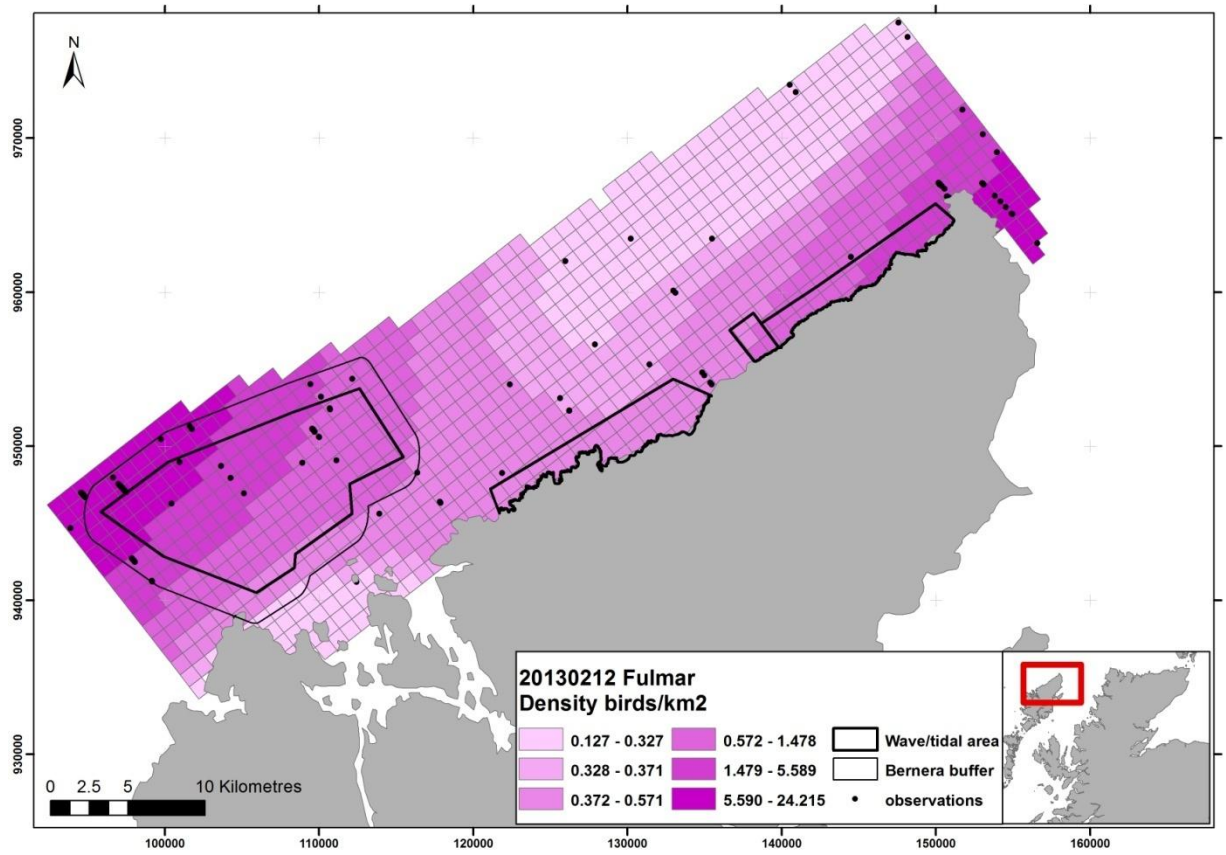


Figure 133 - February fulmar coefficient of variance map from digital aerial survey

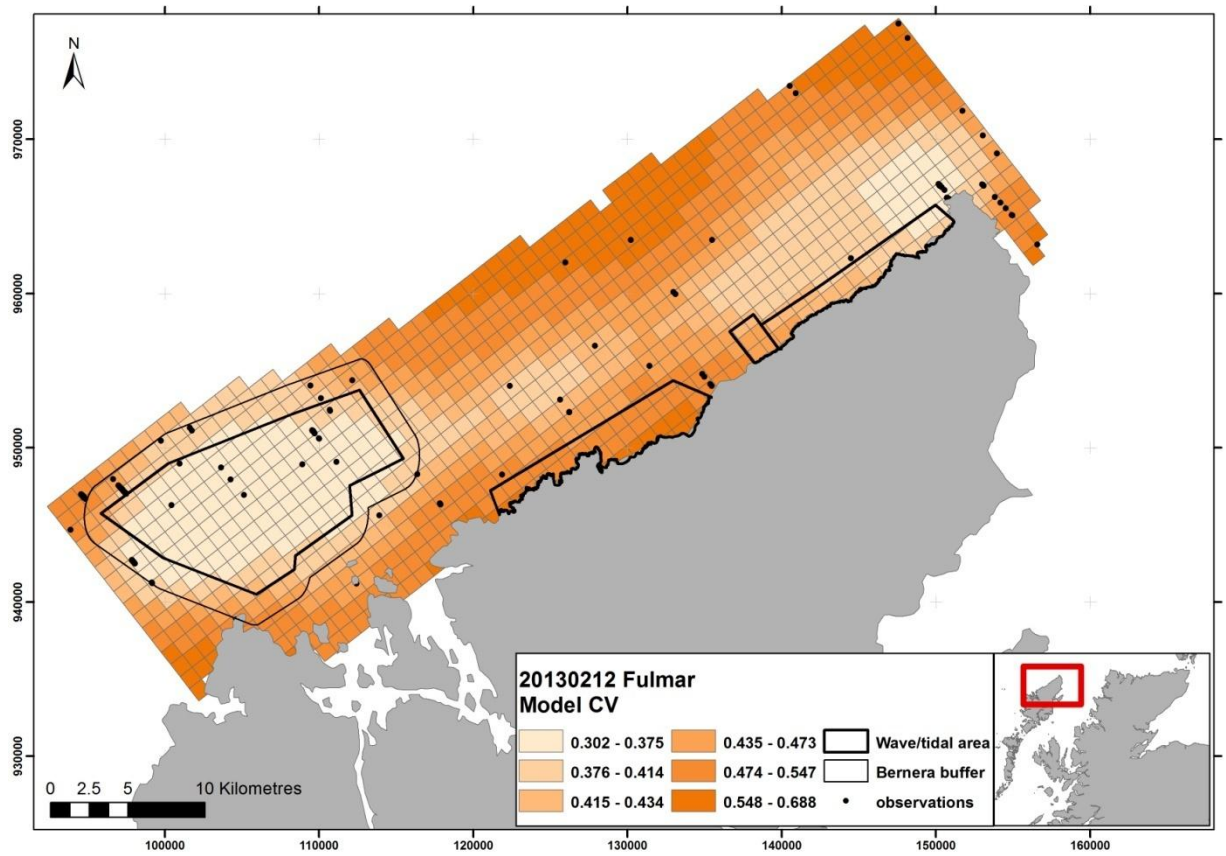


Figure 134 - February gannet density surface model from digital aerial survey

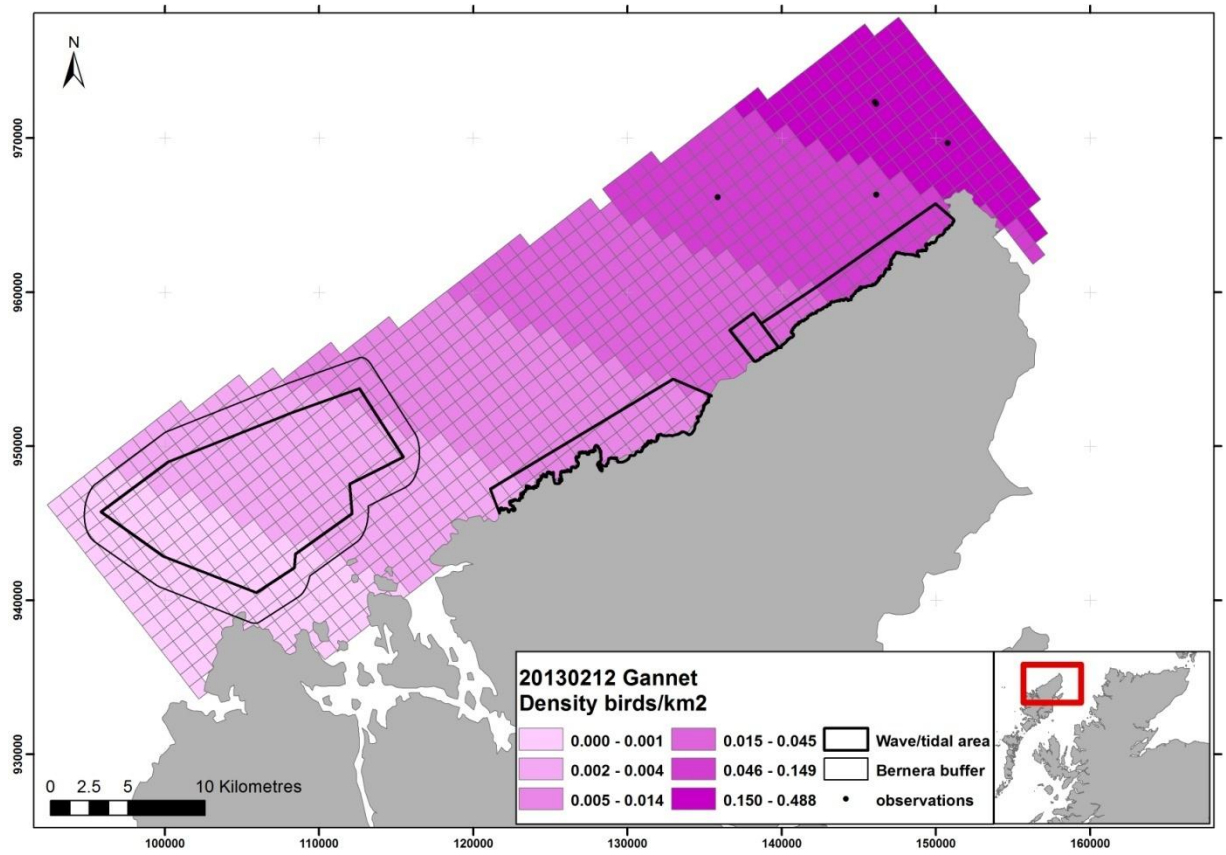


Figure 135 - February gannet coefficient of variance map from digital aerial survey

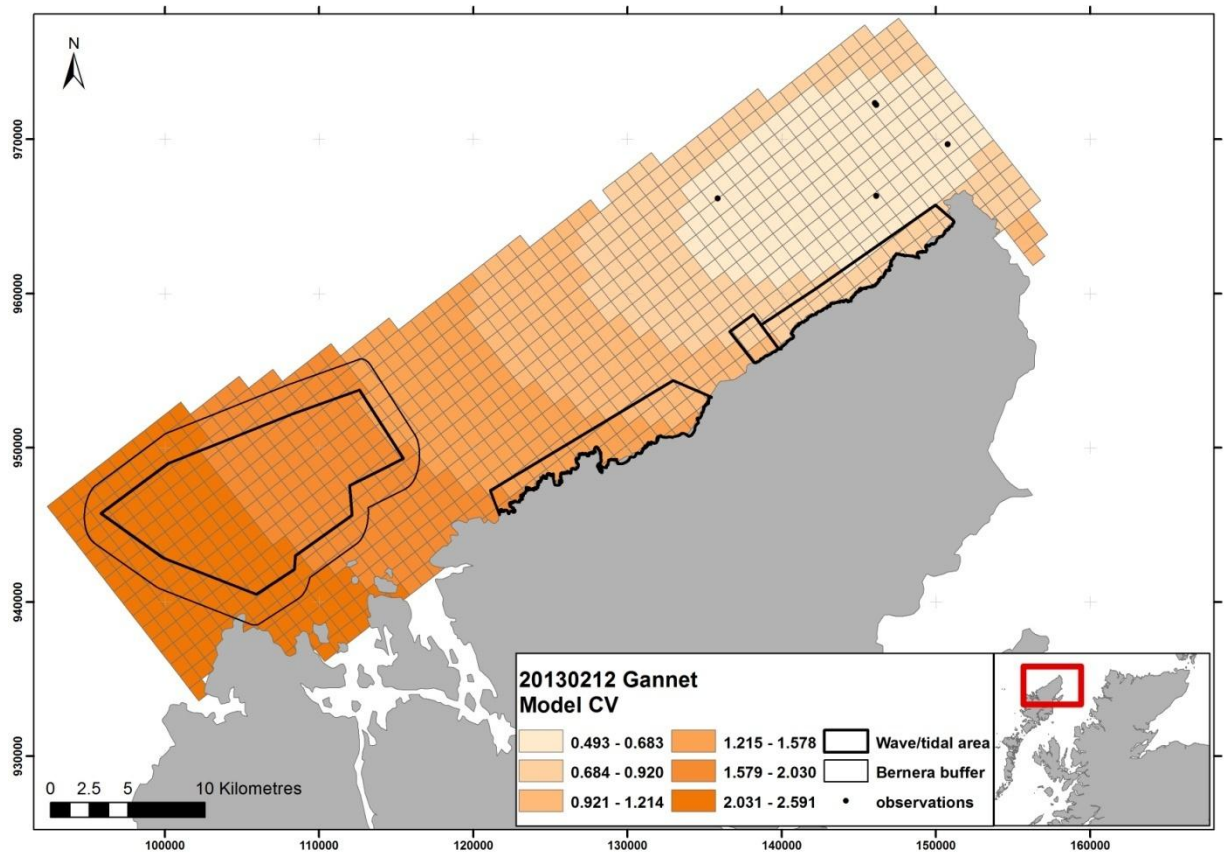


Figure 136 - February auk density surface model from digital aerial survey

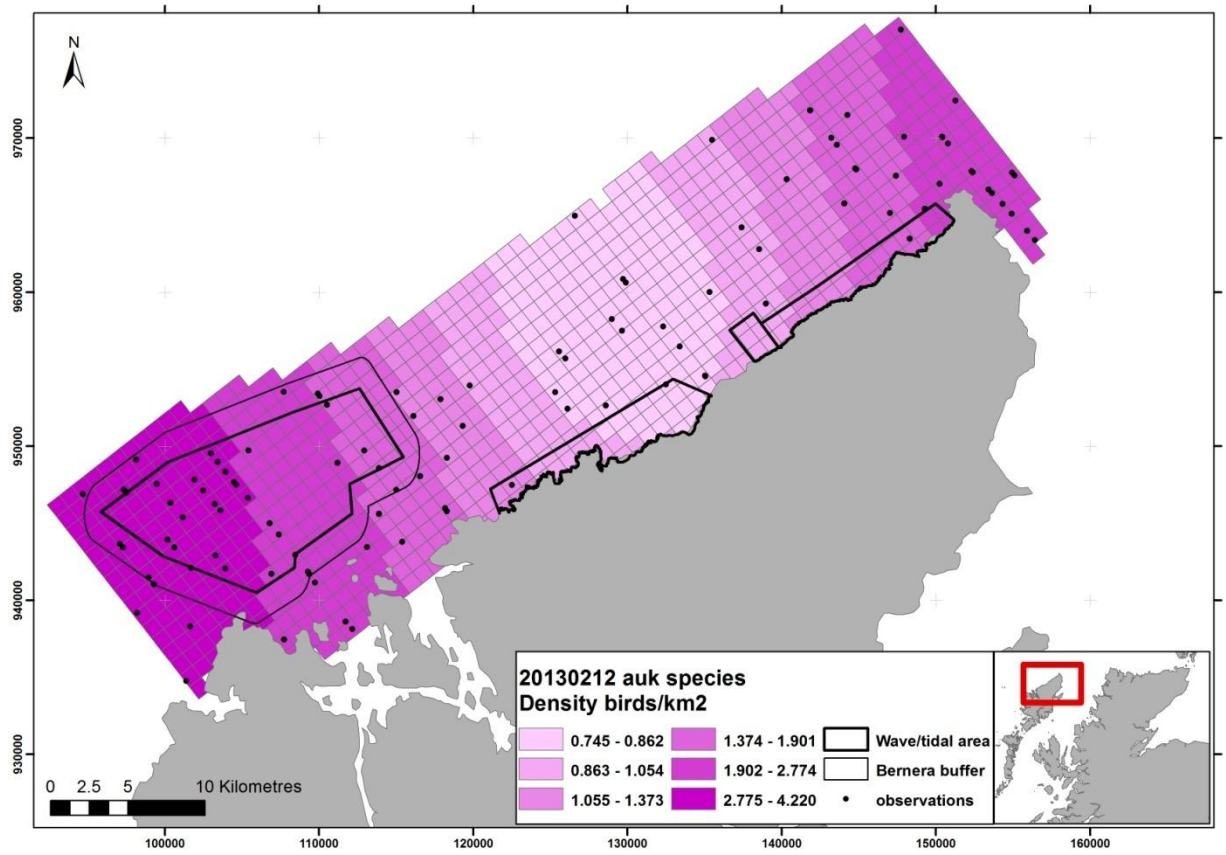


Figure 137 - February auk coefficient of variance map from digital aerial survey

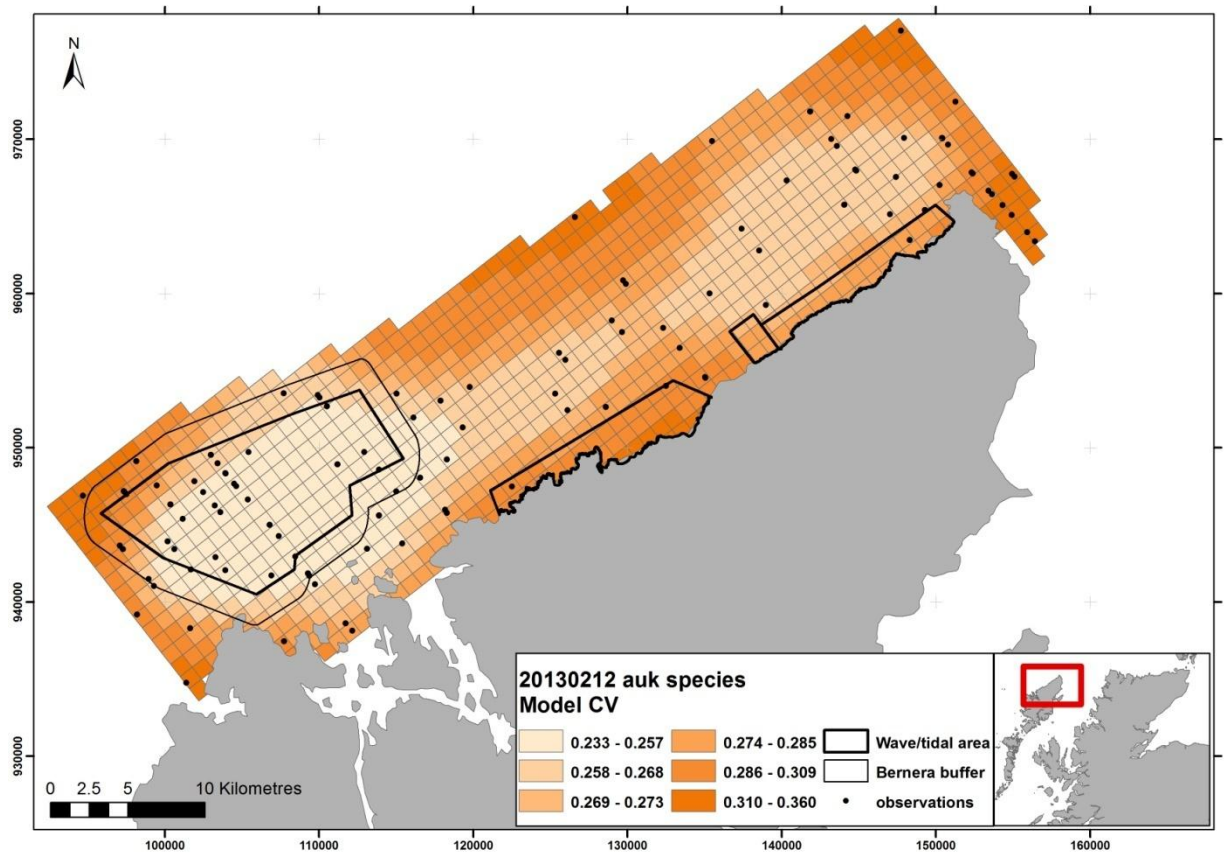


Figure 138 – Comparison of coverage, location and number of records for aerial and vantage point surveys on 19th April 2012. Only records of birds sitting on the water have been included from each dataset for comparability.

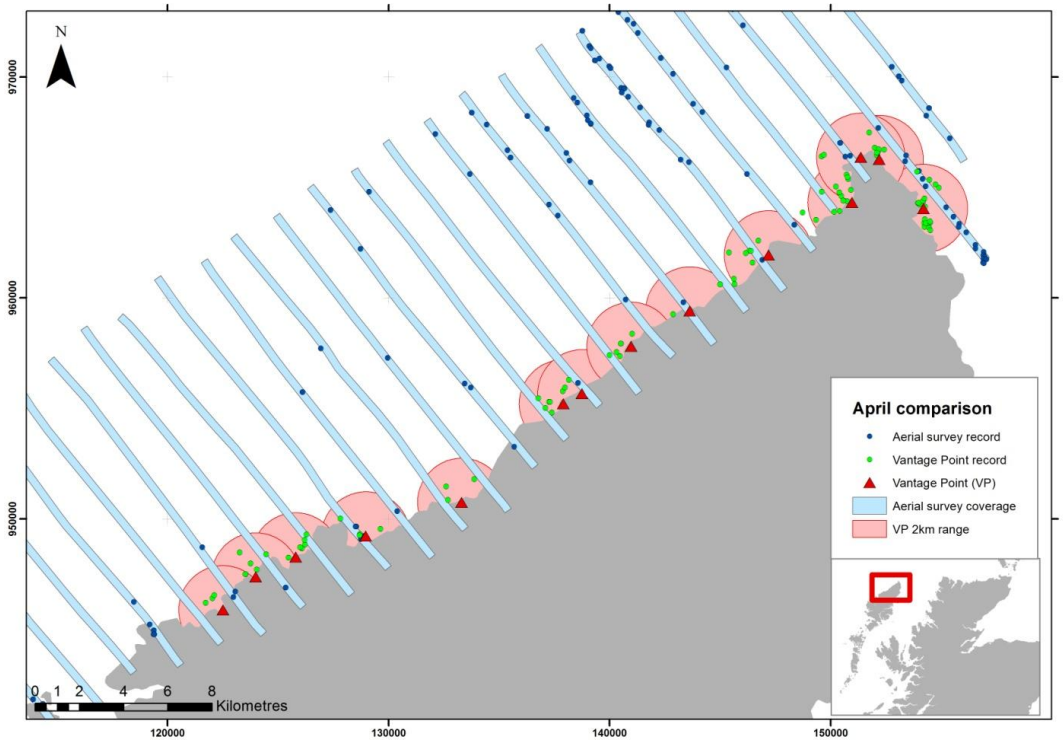


Figure 139 – Comparison of coverage, location and number of records for aerial and vantage point surveys on 18th June 2012. Only records of birds sitting on the water have been included from each dataset for comparability.

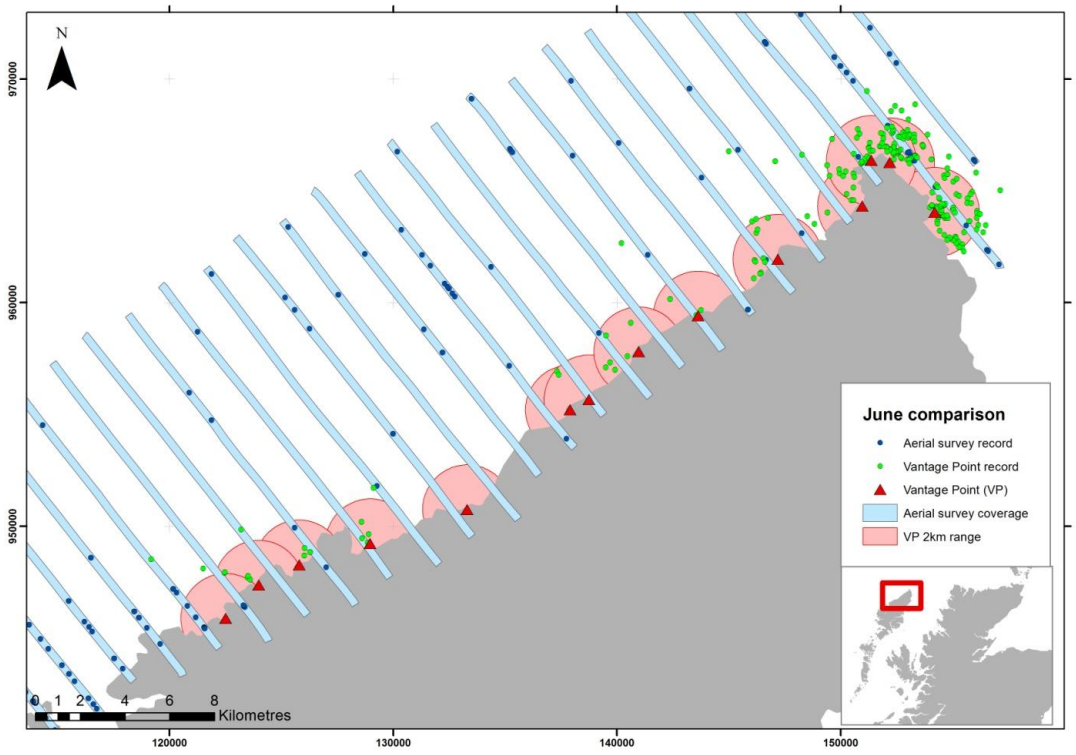


Figure 140 – Comparison of coverage, location and number of records for aerial and vantage point surveys on 26th July 2012. Only records of birds sitting on the water have been included from each dataset for comparability.

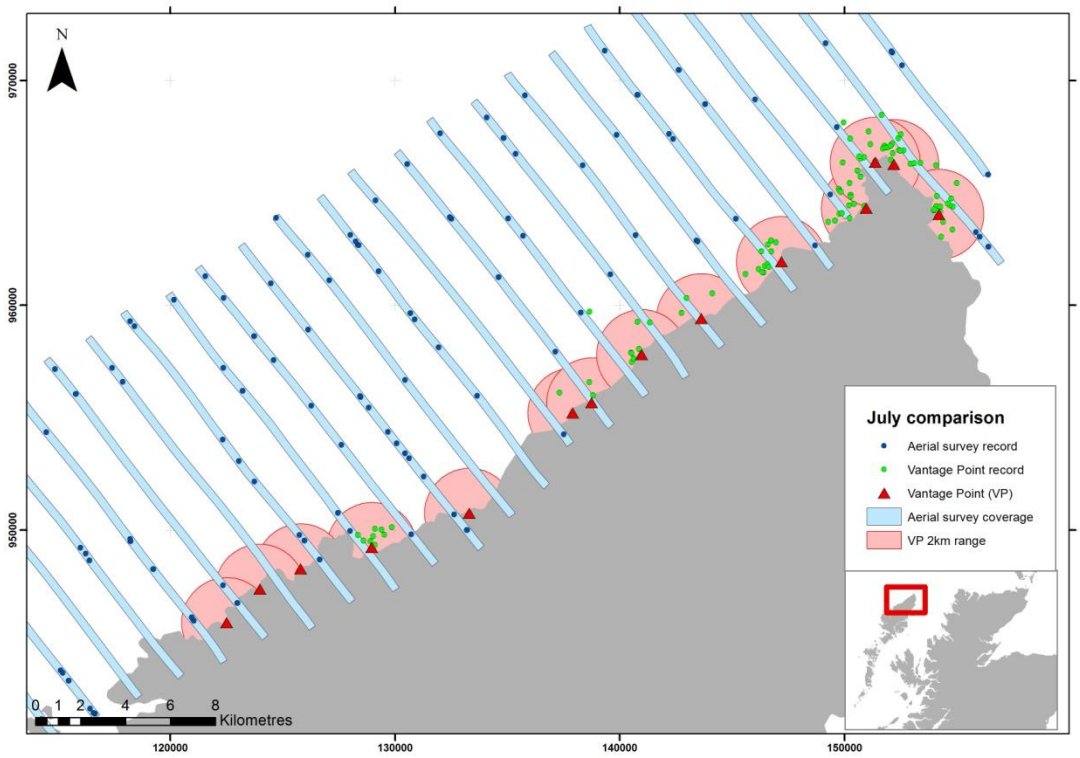


Figure 141 – Comparison of coverage, location and number of records for aerial and vantage point surveys on 22nd September 2012. Only records of birds sitting on the water have been included from each dataset for comparability.

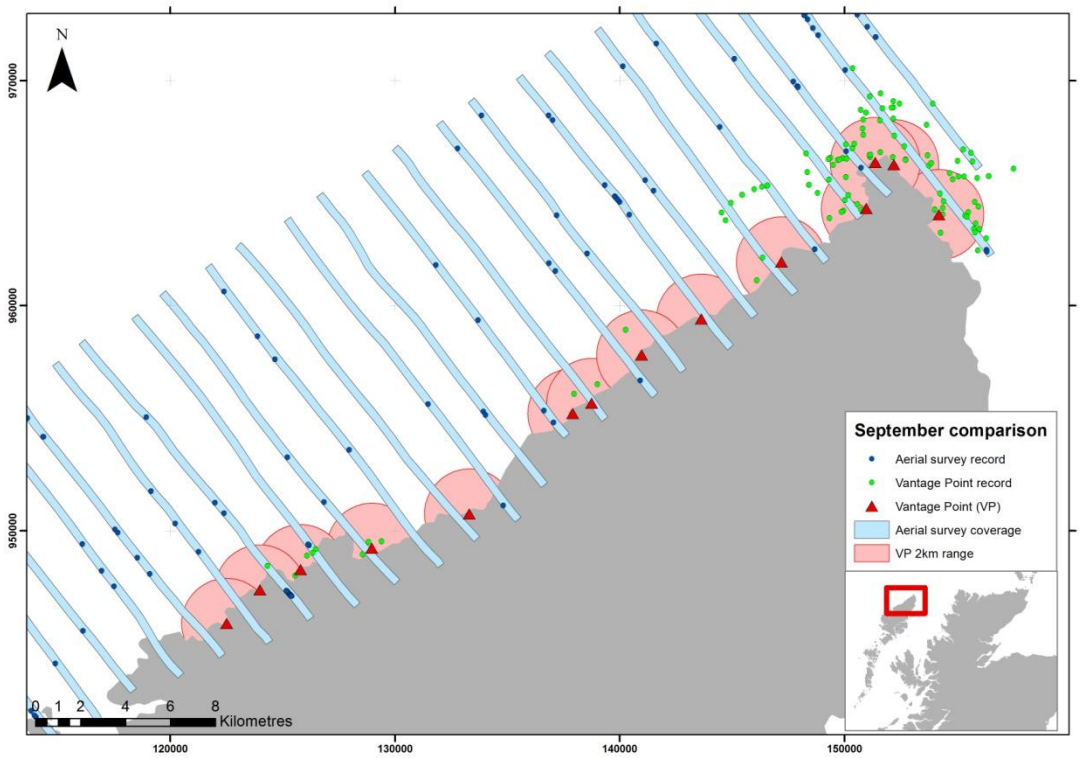


Figure 142 - Comparison of coverage, location and number of records for aerial and vantage point surveys on 17th December 2012. Only records of birds sitting on the water have been included from each dataset for comparability.

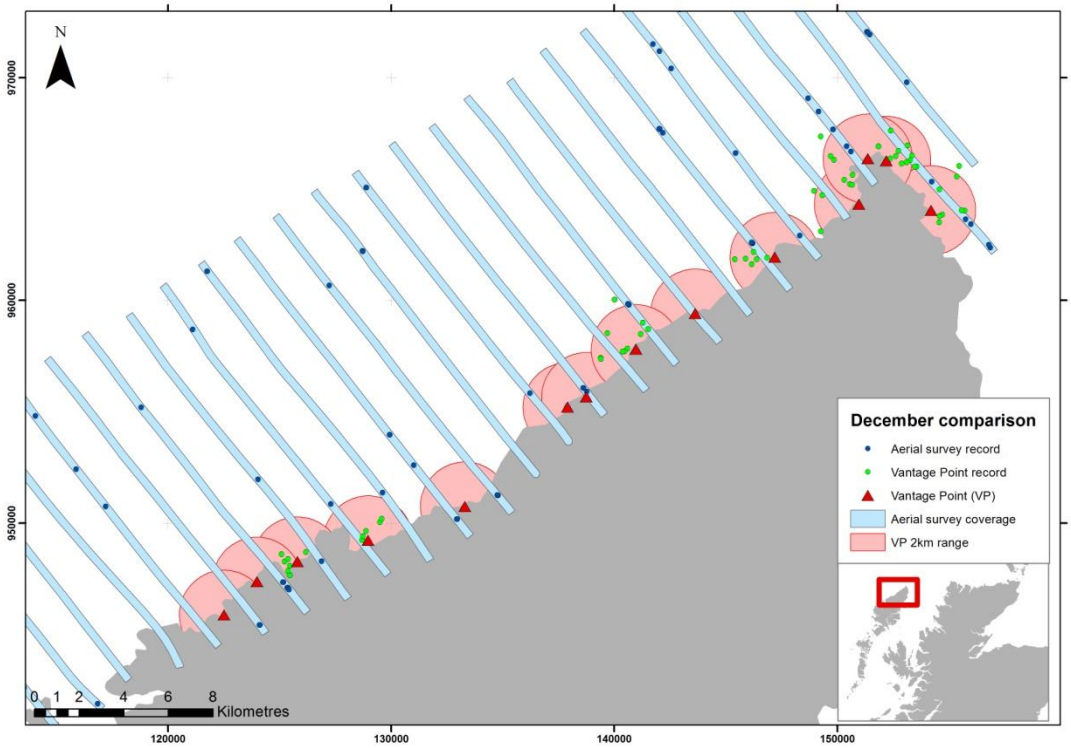


Figure 143 – April to July guillemot densities from Vantage Point (VP) counts around the Butt of Lewis. The horizontal axis shows the distance from the VP (in any direction) and the 'depth' axis shows the actual distance from coast. Auk densities in these distance from coast bands from the four aerial survey transects around the Butt of Lewis surveyed between April and July are shown on the right (in blue) for comparison

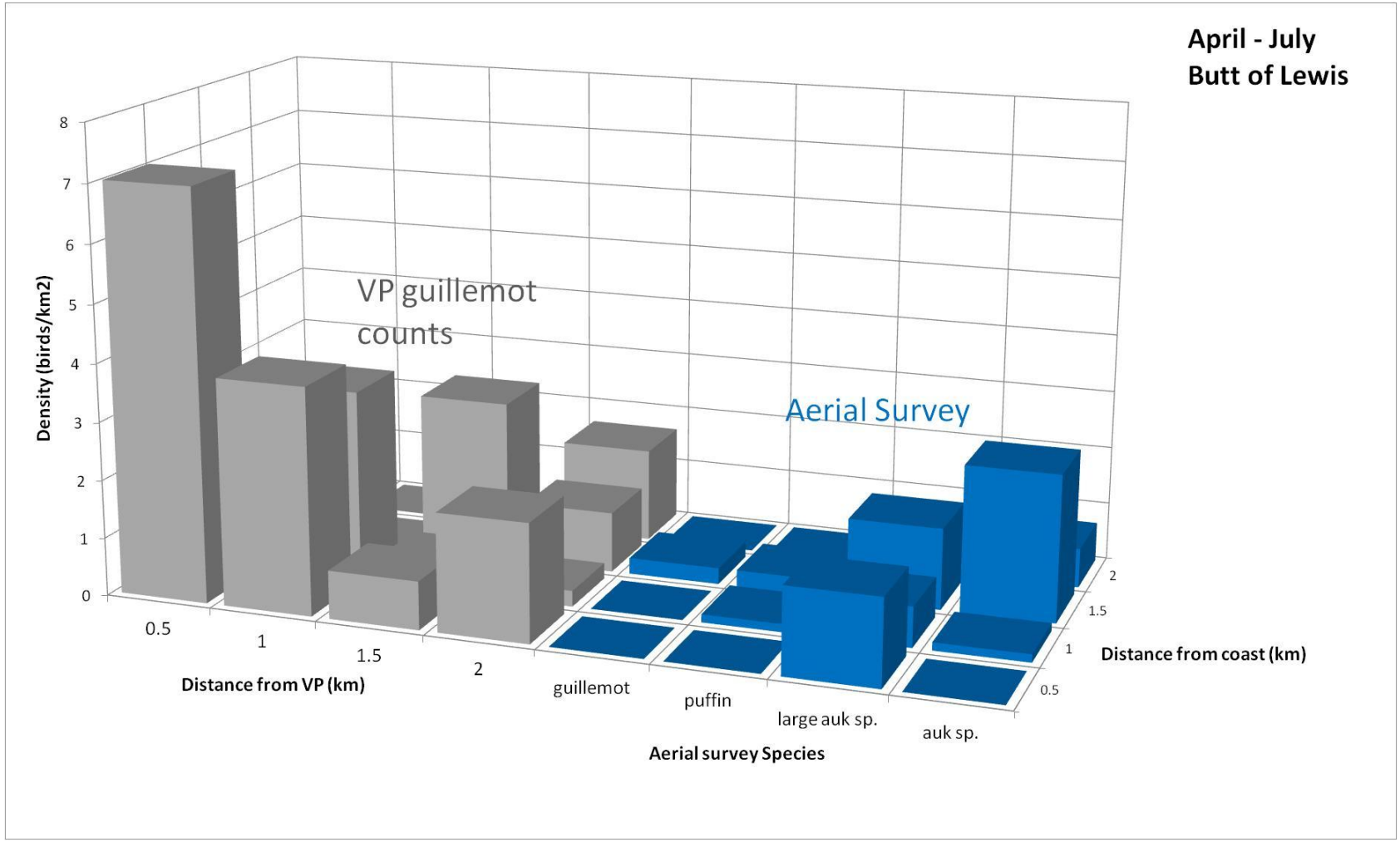


Figure 144 - April to July razorbill densities from Vantage Point (VP) counts around the Butt of Lewis. The horizontal axis shows the distance from the VP (in any direction) and the 'depth' axis shows the actual distance from coast. Auk densities in these distance from coast bands from the four aerial survey transects around the Butt of Lewis surveyed between April and July are shown on the right (in blue) for comparison

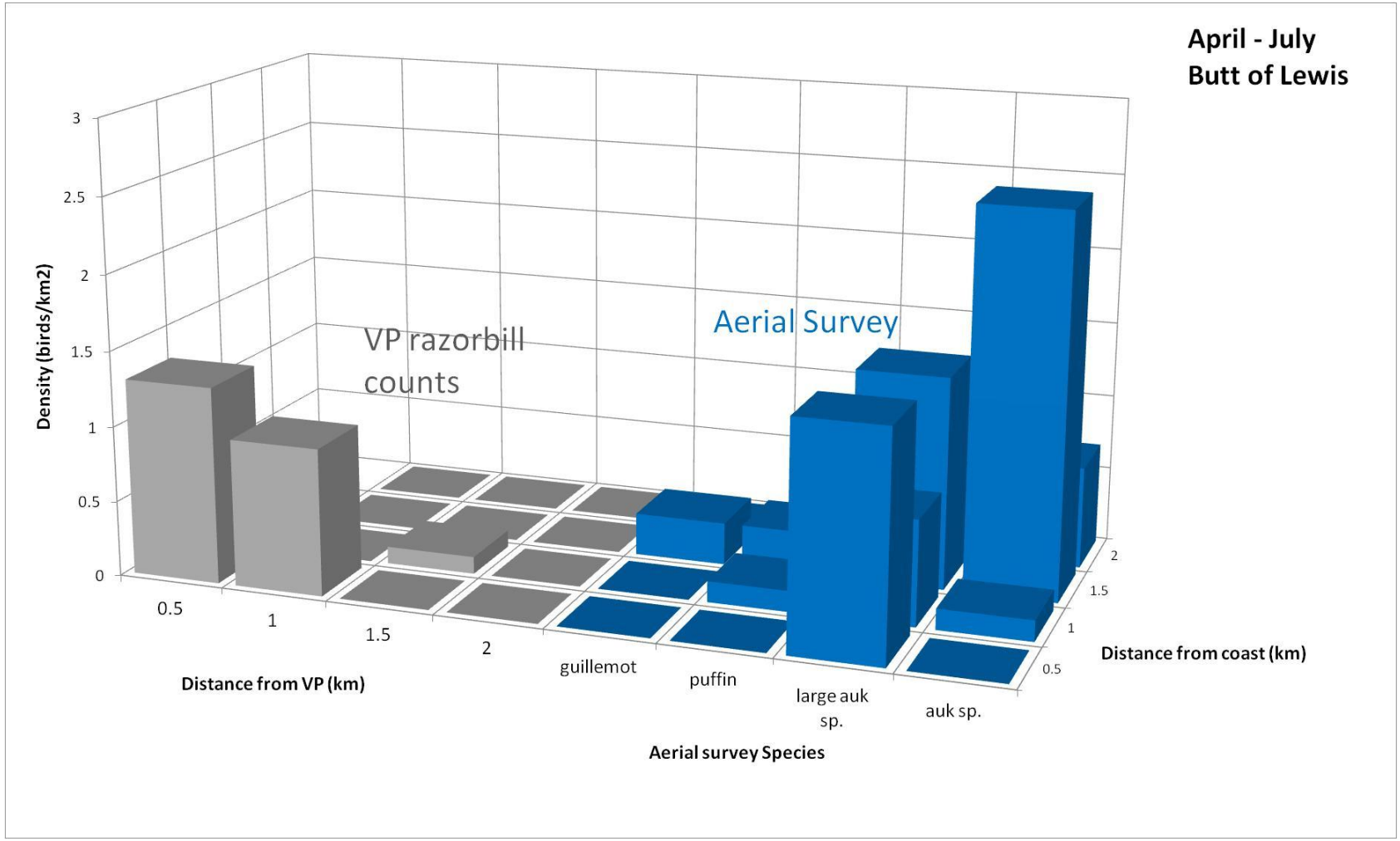


Figure 145 - April to July black guillemot densities from Vantage Point (VP) counts around the Butt of Lewis. The horizontal axis shows the distance from the VP (in any direction) and the 'depth' axis shows the actual distance from coast. Auk densities in these distance from coast bands from the four aerial survey transects around the Butt of Lewis surveyed between April and July are shown on the right (in blue) for comparison

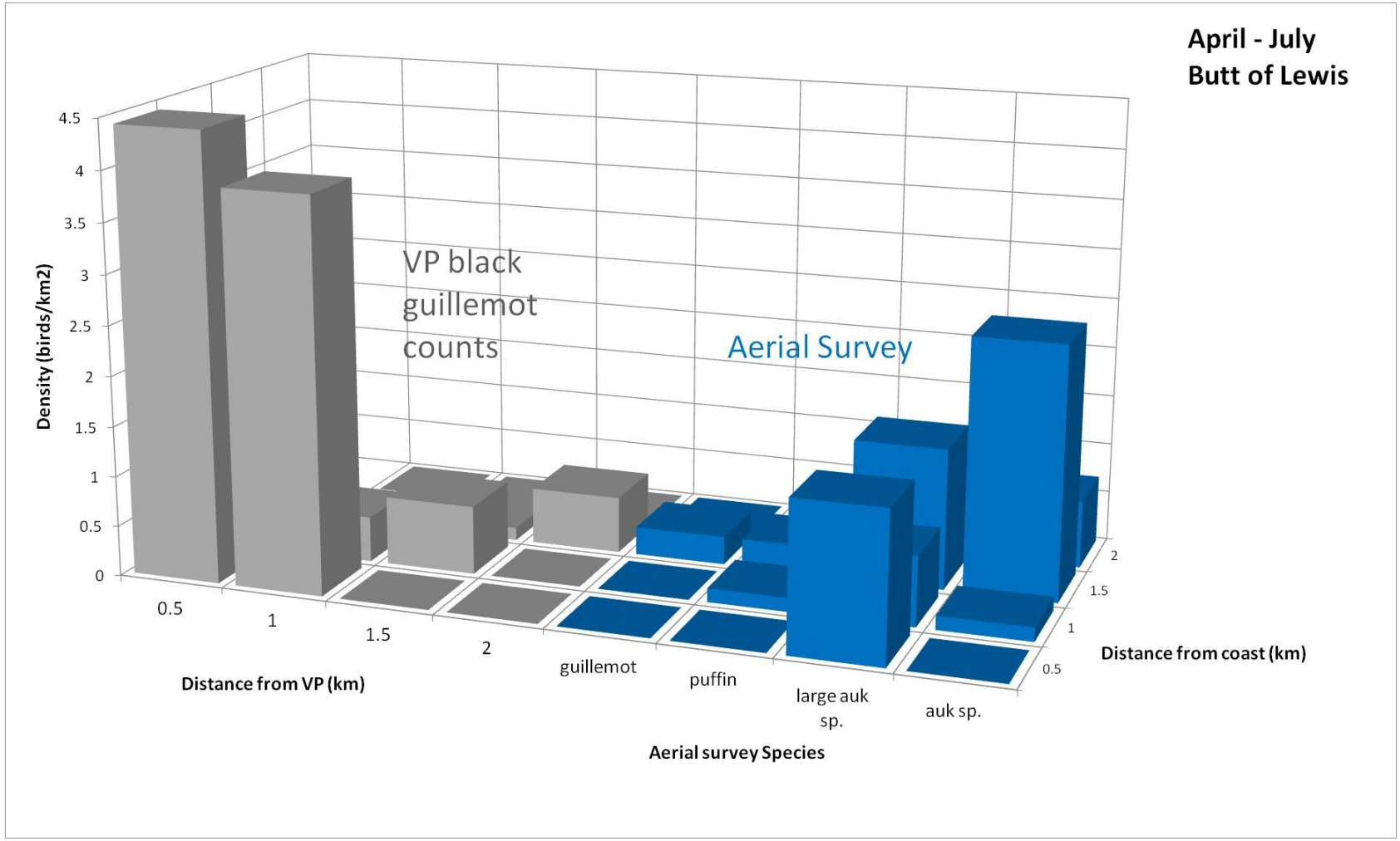


Figure 146 - April to July puffin densities from Vantage Point (VP) counts around the Butt of Lewis. The horizontal axis shows the distance from the VP (in any direction) and the 'depth' axis shows the actual distance from coast. Auk densities in these distance from coast bands from the four aerial survey transects around the Butt of Lewis surveyed between April and July are shown on the right (in blue) for comparison

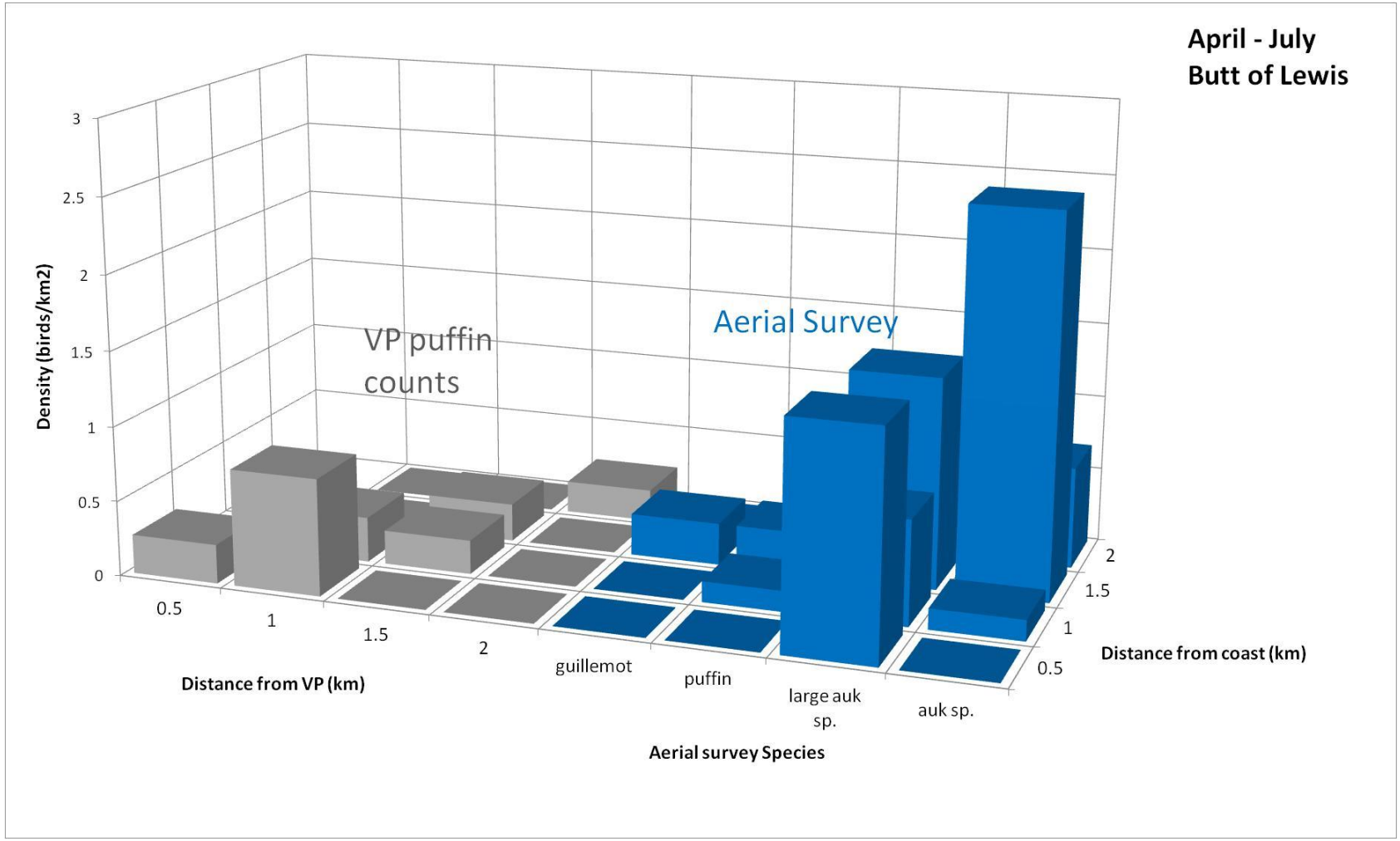


Figure 147 - April to July guillemot densities from Vantage Point (VP) counts on the west coast of Lewis. The horizontal axis shows the distance from the VP (in any direction) and the 'depth' axis shows the actual distance from coast. Auk densities in these distance from coast bands from the corresponding aerial survey transects (5-21) along the west coast of Lewis surveyed between April and July are shown on the right (in blue) for comparison

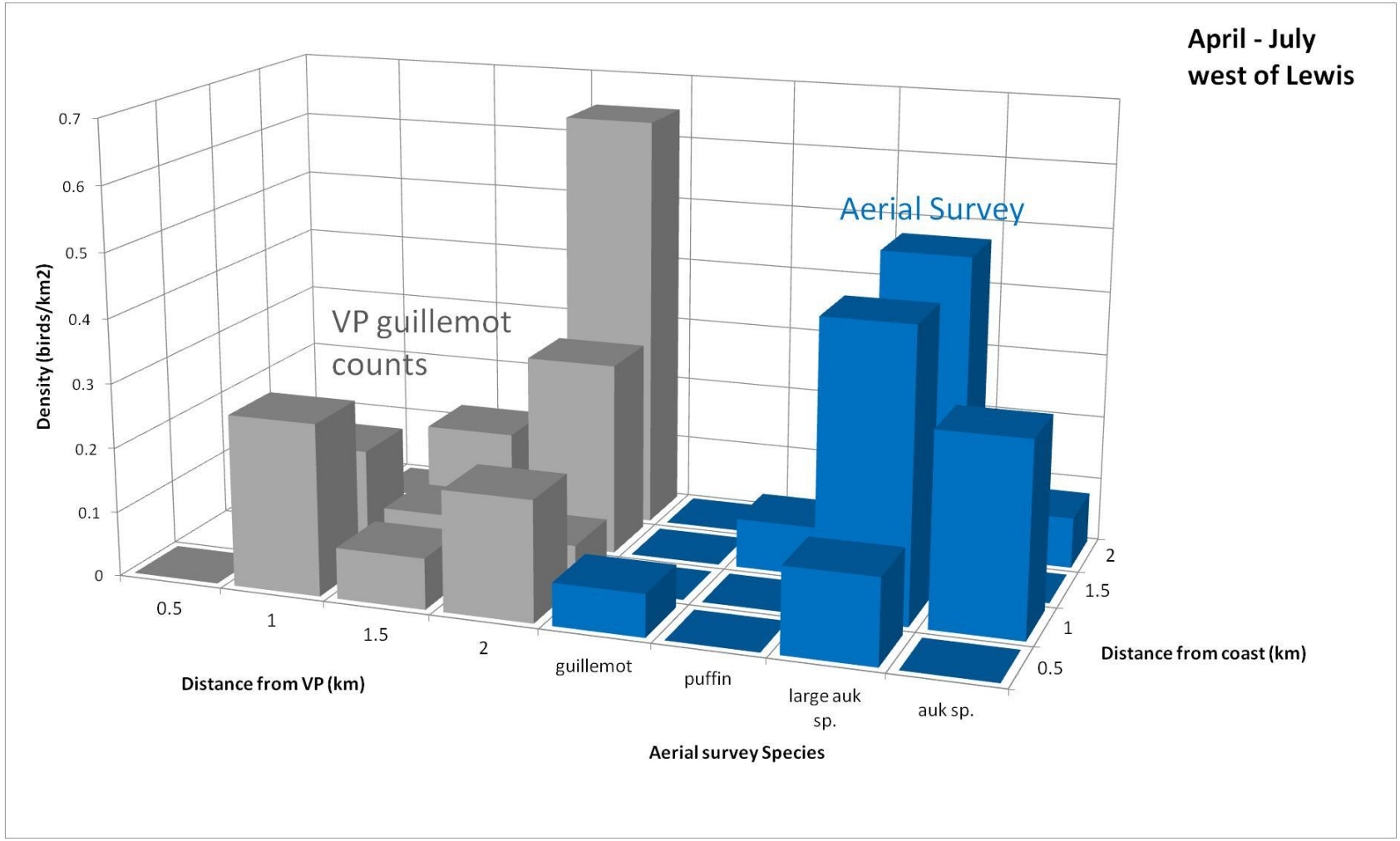


Figure 148 - April to July razorbill densities from Vantage Point (VP) counts on the west coast of Lewis. The horizontal axis shows the distance from the VP (in any direction) and the 'depth' axis shows the actual distance from coast. Auk densities in these distance from coast bands from the corresponding aerial survey transects (5-21) along the west coast of Lewis surveyed between April and July are shown on the right (in blue) for comparison

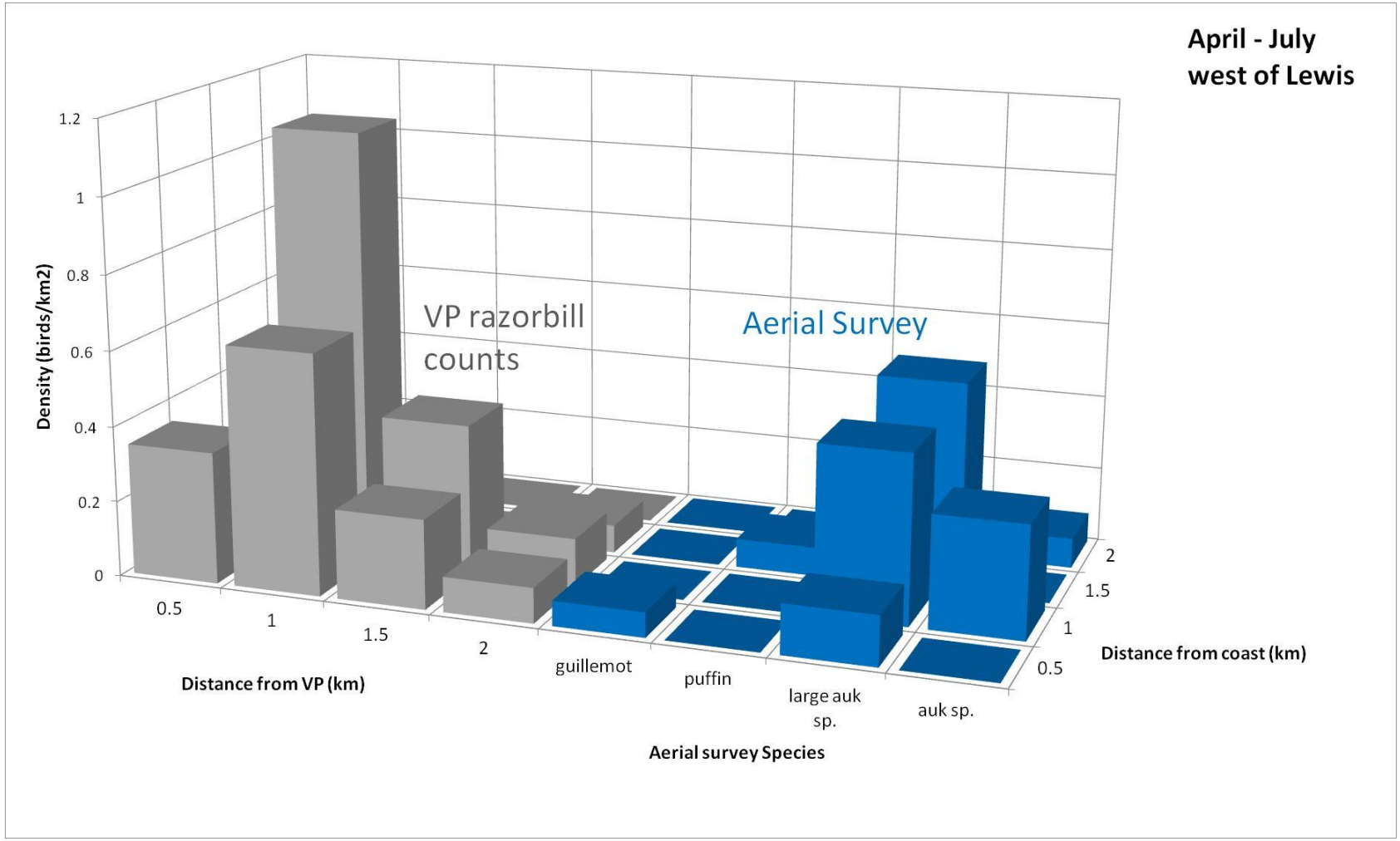


Figure 149 - April to July black guillemot densities from Vantage Point (VP) counts on the west coast of Lewis. The horizontal axis shows the distance from the VP (in any direction) and the 'depth' axis shows the actual distance from coast. Auk densities in these distance from coast bands from the corresponding aerial survey transects (5-21) along the west coast of Lewis surveyed between April and July are shown on the right (in blue) for comparison

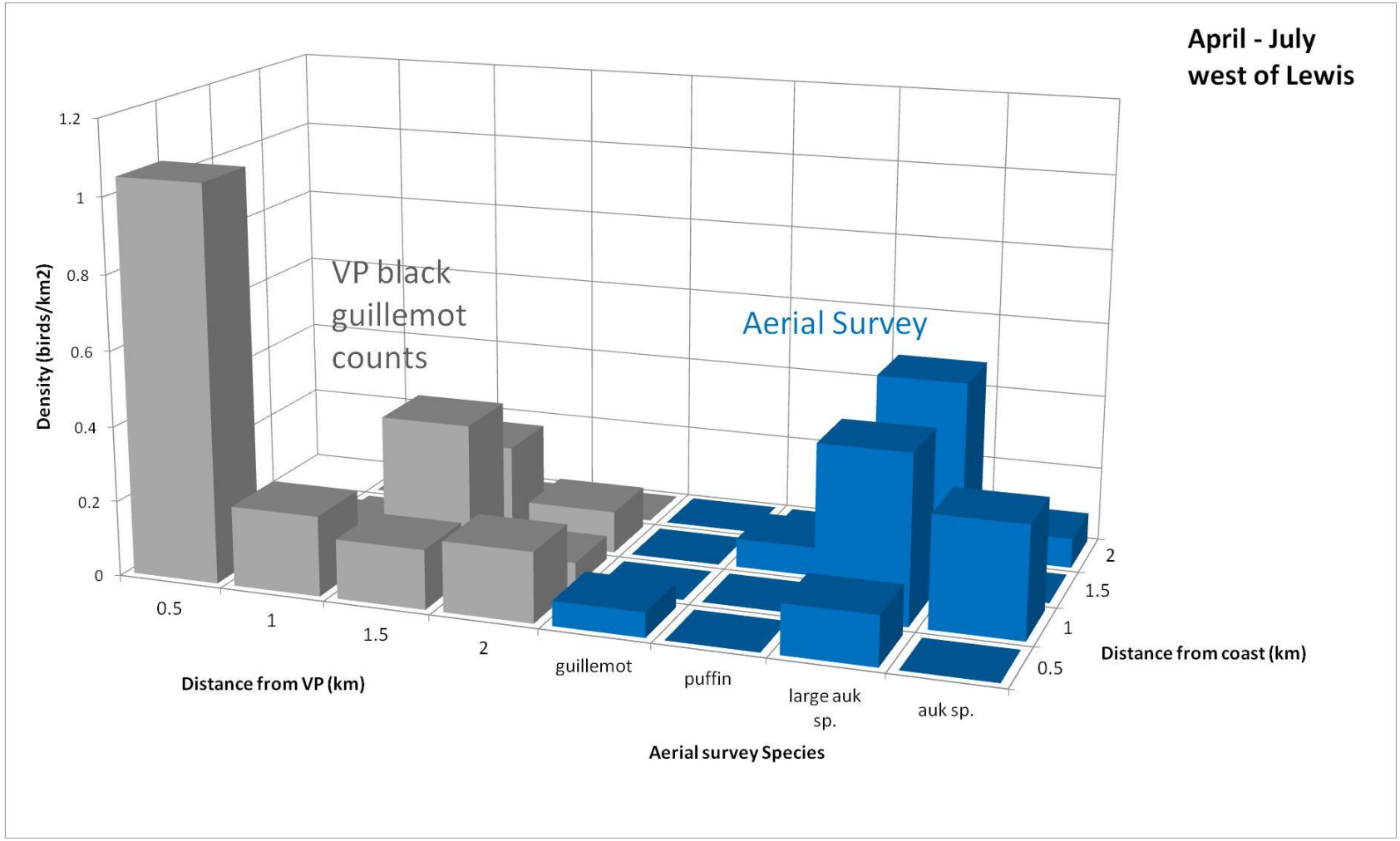


Figure 150 - April to July puffin densities from Vantage Point (VP) counts on the west coast of Lewis. The horizontal axis shows the distance from the VP (in any direction) and the 'depth' axis shows the actual distance from coast. Auk densities in these distance from coast bands from the corresponding aerial survey transects (5-21) along the west coast of Lewis surveyed between April and July are shown on the right (in blue) for comparison

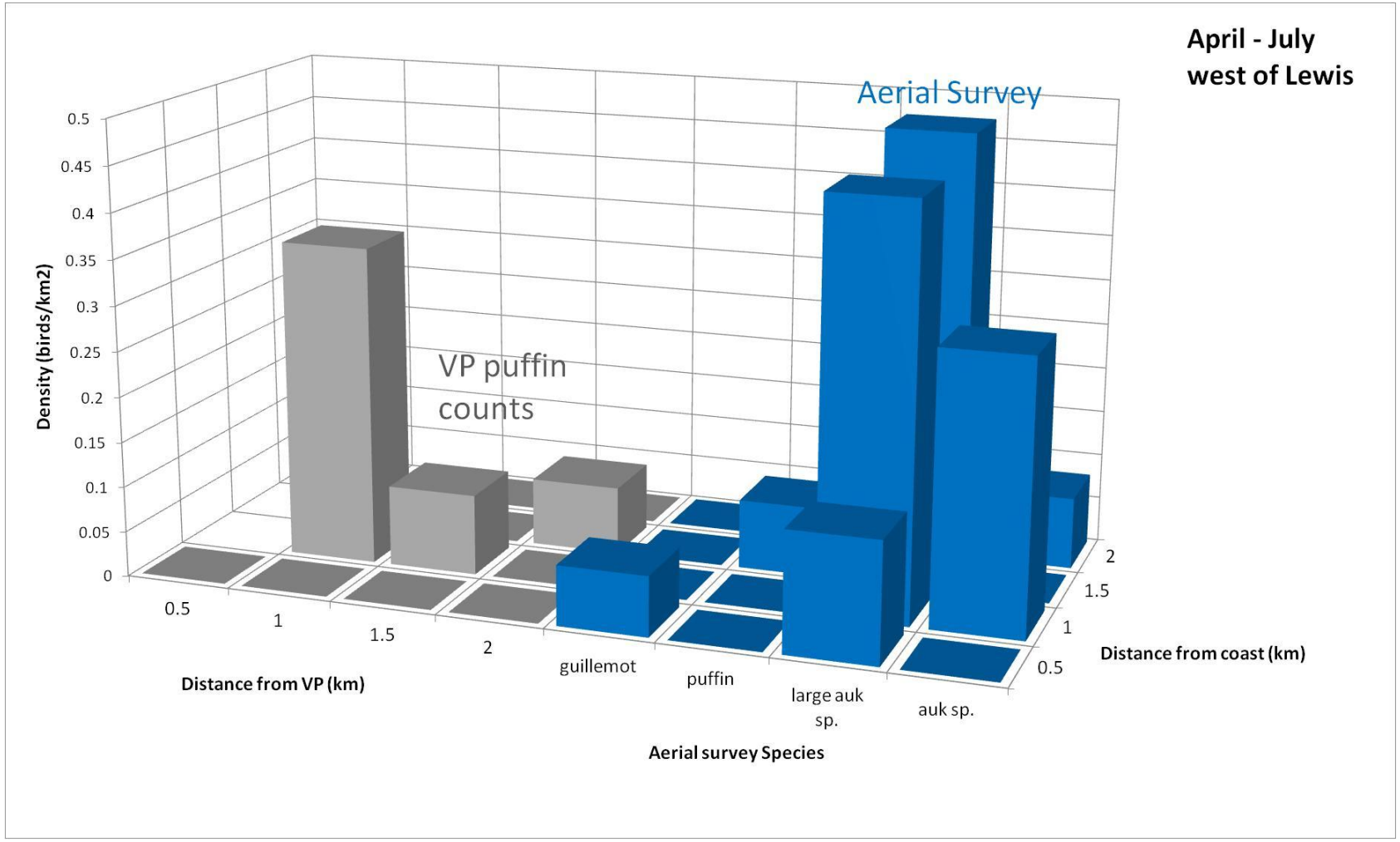


Figure 151 - April to July auk densities from Vantage Point (VP) counts on the west coast of Lewis. The horizontal axis shows the distance from the VP (in any direction) and the 'depth' axis shows the actual distance from coast. Auk densities in these distance from coast bands from the corresponding aerial survey transects (5-21) along the west coast of Lewis surveyed between April and July are shown on the right (in blue) for comparison

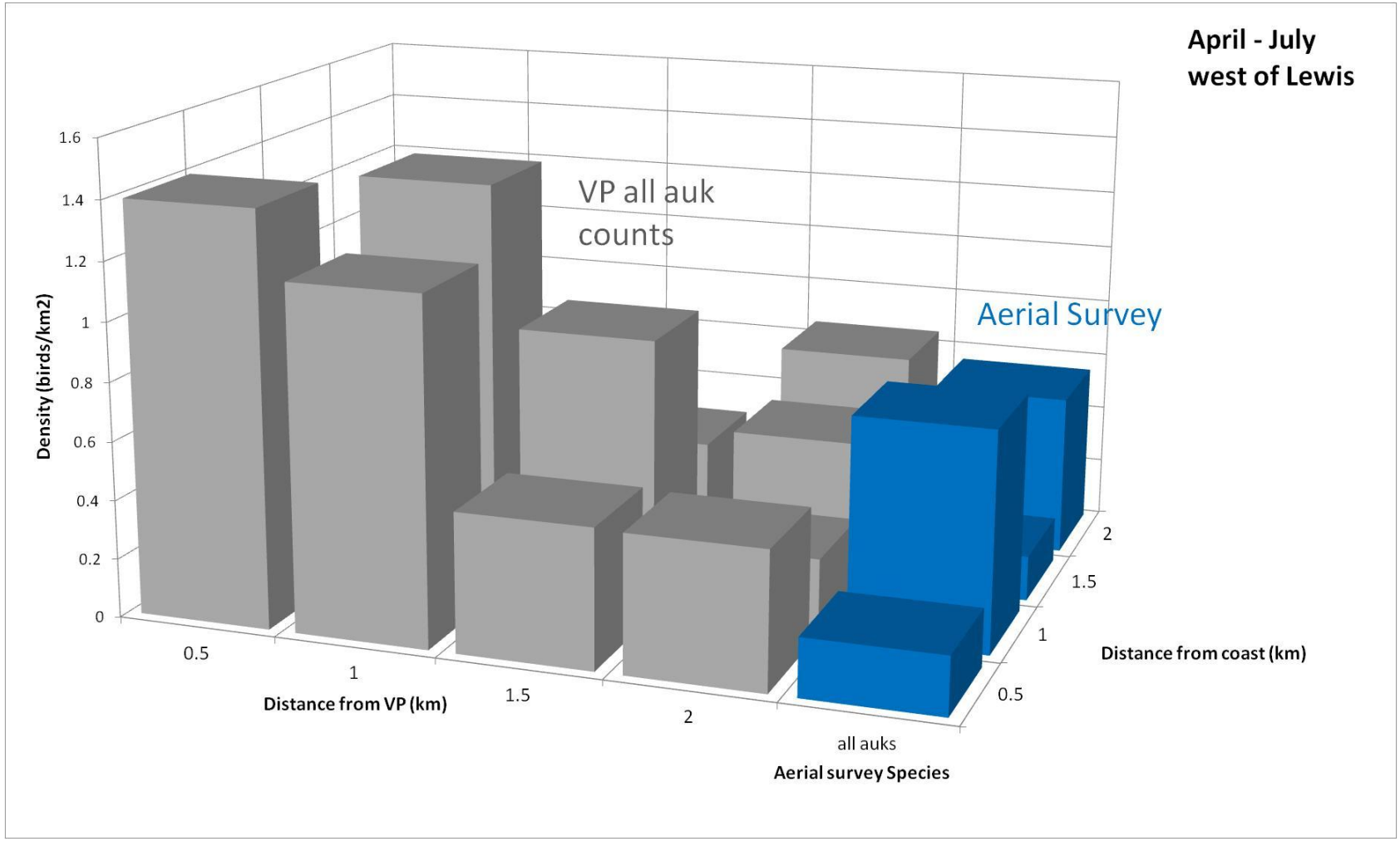
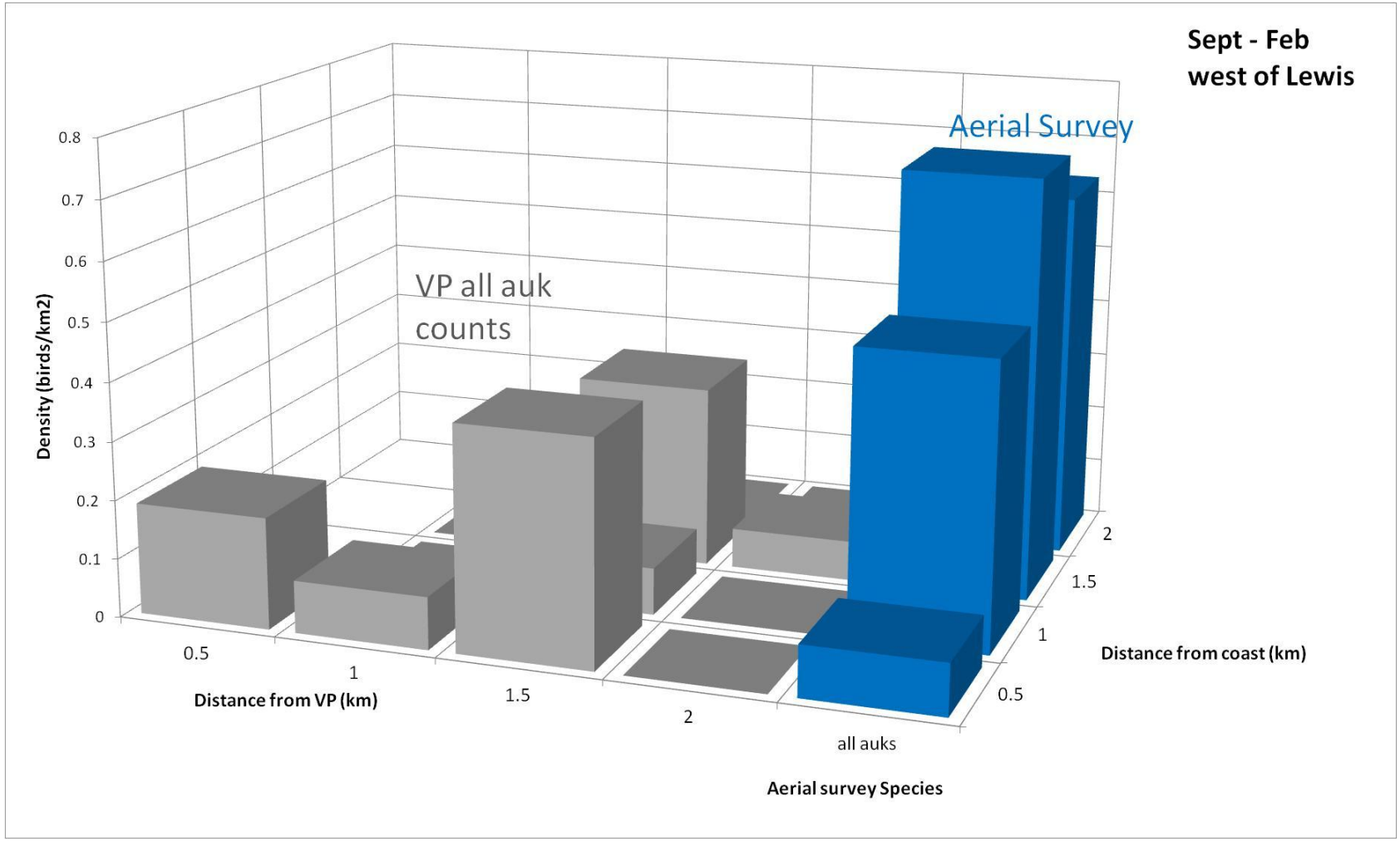


Figure 152 – September to February auk densities from Vantage Point (VP) counts on the west coast of Lewis. The majority of records are of black guillemots. The horizontal axis shows the distance from the VP (in any direction) and the 'depth' axis shows the actual distance from coast. Auk densities in these distance from coast bands from the corresponding aerial survey transects (5-21) along the west coast of Lewis surveyed between September and February are shown on the right (in blue) for comparison



APPENDIX II. Tables

Table 2 - Summary of shore point counts undertaken to compliment aerial surveys along the NW coast (Butt of Lewis southwest to Great Berneray). A tick symbol indicates that a count was undertaken. The Shader shore point was counted from grid ref NB37912/55211 on the April survey (*). The SHA and MEL shore points were counted on the day before that shown for May and September. 'dis' indicates that surveys were discontinued due to the poor view of the sea from that shore point. 'n.c.' indicates that no count was made, either due to unsuitable sea conditions (summer) or time constraints due to day length (winter). Note the June aerial survey was cancelled. Map IDs relate to locations on Figure 1

Map ID	Shore Point Name	Code	Grid reference	19 Apr 2012	02 May 2012	18 Jun 2012	26 Jul 2012	22 Sep 2012	16 Dec 2012	02 Feb 2013
1	Dalbeg	DAL	22508 45887	✓	dis.	dis.	dis.	dis.	dis.	dis.
2	South Shawbost	SSH	23991 47372	✓	✓	✓	n.c.	✓	n.c.	n.c.
3	North Shawbost	NSH	25797 48282	✓	✓	✓	n.c.	✓	✓	✓
4	Bragar	BRA	28971 49230	✓	✓	✓	✓	✓	✓	✓
5	Brue	BRU	33311 50751	✓	dis.	dis.	dis.	dis.	dis.	dis.
6*&7	Shader	SHA	38748 55663*	n.c.	✓	✓	✓	✓	n.c.	n.c.
8	Melbost	MEL	40974 57811	✓	✓	✓	✓	✓	✓	✓
9	South Galston	SGA	43631 59411	✓	✓	✓	✓	✓	n.c.	n.c.
10	Aird Dell	AIR	47192 61950	✓	✓	✓	✓	✓	✓	✓
11	Swainbost	SWA	50973 64320	✓	✓	✓	✓	✓	✓	✓
12	Butt of Lewis West	BLW	51367 66366	n.c.	✓	✓	✓	✓	n.c.	✓
13	Butt of Lewis East	BLE	52195 66265	✓	✓	✓	✓	✓	✓	✓
14	Port of Ness	PON	54198 64050	✓	✓	✓	✓	✓	✓	✓

Shore points with restricted views or poor elevation were given lower priority; counts were completed at these only if there was sufficient time on the survey day. Note the June aerial survey was cancelled. The Upper Shader shore point used on the April survey was subsequently dropped in favour of the nearby LWA vantage point. On most occasions the LWA VPs were counted either the day before or day after the date shown.

Table 3 – Names and grid references of Loch Roag vantage point locations. Map IDs relate to locations on Figure 1

Map ID	Shore Vantage Point Name	VP easting	VP northing
LR01	Cliobh	108673	936531
LR02	Bhaltos	109956	936597
LR03	Miabhaig	109319	934039
LR04	Geisiadar	111922	932395
LR05	Einacleit	112177	928337
LR06	Giosla	113418	925038
LR07	Bernera bridge	116496	934249
LR08	Sruth Iarsiadair	116055	934265
LR09	Tobson	113491	938215
LR10	Crothair	115922	939402
LR11	Circebost/Totarol	118941	934339
LR12	Lundal	118601	932677
LR13	Linsiadar	121169	931135
LR14	Beinn Hulabhig	122586	929821
LR15	Tolsta Chaolais	118944	938238
LR16	Breasecleit /Pier	120692	935973
LR17	Callinish Pier	121300	932600
LR18	Garynahire Bridge	123400	931400
LR19	Carishader	109800	933400
LR20	Bosta E	114500	940250
LR21	Bosta W	113800	940400
LR22	Borrowston	119000	942400
LR23	Valasay	114800	936100
LR24	Barraglom	117700	934500
LR25	Hacklete	114500	934800
LR26	Breaclete	116100	937700
LR27	Dubh Thob	118300	935900

Table 4 – Species included in species groups

Species group	Species included	Comments
Auk species	Guillemot, Razorbill, Puffin, Little Auk, Black Guillemot	Used when features are not available to allow further identification to a smaller class or species
Large Auk	Guillemot, Razorbill	Used when Puffin/Little Auk can be excluded on size and Black Guillemot on plumage
Small Auk	Puffin, Little Auk	Used when the bird is definitely an auk smaller than Guillemot or Razorbill but further features are not clearly defined
Auk / small gull	Guillemot, Razorbill, Puffin, Little Auk, Black Guillemot, Kittiwake, Black-headed Gull, Common Gull, Little Gull	Usually used when poor contrast makes apparently white objects unreliable
Gull species	Kittiwake, Black-headed Gull, Common Gull, Little Gull, Great Black-backed Gull, Lesser Black-backed Gull, Herring Gull, plus rarer gulls, such as Glaucous Gull and Iceland Gull	Used for gulls when size and other features do not allow identification to a smaller class or species. In some cases some species falling into this category could be excluded, however, it would be impractical to create species groups for all eventualities
Small gull species	Kittiwake, Black-headed Gull, Common Gull, Little Gull	Usually used for small gulls sitting on the water when other identification features are not obvious
Small Gull (excluding Little)	Kittiwake, Black-headed Gull, Common Gull	Introduced because Little Gull can frequently be excluded on size alone
Large gull species	Great Black-backed Gull, Lesser Black-backed Gull, Herring Gull, Glaucous Gull, Iceland Gull	Often used for sitting immature birds where plumage is less diagnostic, or for images where contrast makes colour unreliable
Pale Gull	Kittiwake, Black-headed Gull, Common Gull, Herring Gull, Glaucous Gull, Iceland Gull	Used when mantle colour but not size can be distinguished in adult birds, most often loafing on sand or rocks where size is less obvious due to the oblique angle
Large Gull Including Common	Common Gull, Great Black-backed Gull, Lesser Black-backed Gull, Herring Gull, Glaucous Gull, Iceland Gull	Primarily used for immature birds, where aspect or contrast prevents further identification

Species group	Species included	Comments
Kittiwake / Common Gull	Kittiwake, Common Gull	
Grey gull species (Herring or Common)	Herring Gull, Common Gull	
Black-backed gull species	Great Black-backed Gull, Lesser Black-backed Gull	
Fulmar / gull species	Fulmar, Kittiwake, Black-headed Gull, Common Gull, Little Gull, Great Black-backed Gull, Lesser Black-backed Gull, Herring Gull, Glaucous Gull, Iceland Gull	Used almost exclusively for sat birds, often when contrast obscures darker plumage
Fulmar / Small Gull (excluding Little Gull)	Fulmar, Kittiwake, Black-headed Gull, Common Gull, Great Black-backed Gull, Lesser Black-backed Gull, Herring Gull, Glaucous Gull, Iceland Gull	Little Gull can be excluded on size alone in cases where Fulmar cannot be excluded
Big Bird	All bird species larger than 48cm in length (minimum length in range provided for Lesser Black-backed Gull in Collins Bird Guide 2nd edition)	Predominately used as the species group category where Gannet has been identified at the species level. Very rarely used when extreme conditions obscure most or all identifying features apart from size. For example direct sunlight can very occasionally cause sat Eider and Gannet to be indistinguishable. In most cases many species falling into this category could be excluded however it would be impractical to create species groups for all eventualities.
Small Bird	All bird species smaller than 48cm in length (minimum length in range provided for Lesser Black-backed Gull in Collins Bird Guide 2nd edition)	Occasionally groups of terrestrial birds will cross over survey areas and it may not be possible to discern whether these are, for example, a migratory passerine species or a small wader species. Although many other species falling into this category could be excluded it would be impractical to create species groups for all eventualities given their very rare occurrence and, arguably, irrelevance to these surveys
Diver species	Red-throated Diver, Black-throated Diver, Great Northern Diver, White-billed Diver	

Species group	Species included	Comments
Large Auk / Throated Diver	Razorbill, Guillemot, Red-throated Diver, Black-throated Diver	During winter months when both divers and the larger auk species have white faces, it can occasionally be difficult to distinguish them
Duck species	Common Scoter, Surf Scoter, Velvet Scoter, Eider, Wigeon, Gadwall, Teal, Mallard, Pintail, Shoveler, Pochard, Tufted Duck, Scaup, Shelduck, Long-tailed Duck, Goldeneye, Smew, Red-breasted Merganser, Goosander	Used as the species group where a duck species has been identified and when a lack of features makes further identification impossible. Often in large flocks. Although species falling into this category could often be excluded it would be impractical to create species groups for all eventualities when a species cannot be identified
Grebe species	Great Crested Grebe, Red-necked Grebe, Slavonian Grebe, Black-necked Grebe, Little Grebe	The smaller or larger grebe species can almost always be excluded, however, they are usually identified to species anyway and encountered so rarely that more specific species groups have so far been unnecessary
Shearwater species	Manx Shearwater, Balearic Shearwater, Sooty Shearwater, Cory's Shearwater, Great Shearwater	
Large Shearwater	Sooty Shearwater, Cory's Shearwater, Great Shearwater	Used when plumage details are indiscernible but size is apparent
Small Shearwater	Manx Shearwater, Balearic Shearwater	Used when larger species can be excluded but survey area and visible plumage mean that Balearic Shearwater cannot be ruled out
Shearwater species / auk species	Manx Shearwater, Balearic Shearwater, Sooty Shearwater, Cory's Shearwater, Great Shearwater, Guillemot, Razorbill, Puffin, Black Guillemot, Little Auk	Generally assumed to apply only to Manx Shearwater and Guillemot, Razorbill and Puffin
Tern species	Arctic Tern, Common Tern, Little Tern, Sandwich Tern, Roseate Tern, Black Tern	
Arctic / Common Tern	Arctic Tern, Common Tern	The two species are very similar and extremely difficult to separate

Species group	Species included	Comments
Tern (Excluding Little)	Arctic Tern, Common Tern, Sandwich Tern, Roseate Tern, Black Tern	Used when the tern is larger than a small tern however can't be identified further
Tern / small gull	Arctic Tern, Common Tern, Sandwich Tern, Roseate Tern, Black Tern, Kittiwake, Black-headed Gull, Common Gull, Little Gull	Used in certain conditions or angles where small gulls (especially little gulls) can look similar
Skua species	Great Skua , Arctic Skua, Pomarine Skua, Long-tailed Skua	
Skua (Excluding Great)	Arctic Skua, Pomarine Skua, Long-tailed Skua	Used for the smaller skua species that are clearly not Great Skua
Cormorant / Shag	Cormorant, Shag	Can be very difficult to separate. Usually easier in flight
Unidentified storm-petrel	British Storm-Petrel, Leach's Storm Petrel	Used as the two species are very small and superficially similar
Large wader species	Curlew, Whimbrel, Black & Bar-tailed Godwit	Waders godwit sized in length or larger
Medium wader species	Redshank, Spotted Redshank, Woodcock, Snipe, Lapwing etc.	Waders between a Redshank and a godwit in length
Small wader species	Dunlin, Knot, Sanderling, Turnstone, sandpipers, stints, phalaropes, smaller plovers etc	Anything smaller than a Redshank
Wader species		If size is difficult to establish
Passerine species		Mainly used for small passerines. Clearly identified as not a small seabird or wader. Usually small often brown migrating passerines.
Swan species	Mute Swan, Bewick's Swan, Whooper Swan	

Species group	Species included	Comments
Goose species	Canada Goose, Greylag Goose, Bean Goose, Pink-footed Goose, White-fronted Goose, Snow Goose, Barnacle Goose	
Dabbling ducks	Wigeon, Gadwall, Teal, Mallard, Pintail, Shoveler, Pochard, Shelduck	Only used on Inshore areas such as lakes, ponds and rivers
Seal species	Grey Seal, Harbour Seal	
Dolphin species	Bottlenose Dolphin, Common Dolphin, White-beaked Dolphin, White-sided Dolphin, Risso's Dolphin	Although Orca (Killer Whales) are dolphins they would come under Large Cetacean species
Small cetacean species	Harbour Porpoise, dolphin Sp.	Includes Harbour Porpoise and all the dolphin species not including Orca (Killer Whale)
Large cetacean species	Long-finned Pilot whale, Minke Whale, etc, Orca	Any whale species and Orca.
Cetacean species		Sometimes used when size is difficult to judge e.g. Submerged animals, but cetacean features can be identified
Shark species	Basking Shark, Blue Shark, Porbeagle, etc.	Used for any shark sighting
Small cetacean / seal species	Harbour Porpoise, dolphin Sp, Harbour Seal, Grey Seal	Used when features to define either a seal or a small cetacean (e.g. Fluke or flippers) are not visible. This may occur in submerged animals
Cetacean species / seal species / shark species	Cetacean sp., seal sp., shark species	Used when the object is not clear e.g. Adverse weather conditions or submerged or turbid underwater conditions
Jellyfish		Species not usually recorded
Turtle species	Leatherback turtle	Mainly the leatherback turtle occurs in the UK during the summer however odd sightings and standings of other species have been recorded, so these will be recorded where identified

Species group	Species included	Comments
No ID		Used very rarely in adverse weather conditions when features cannot be used to identify objects to any one animal class

Table 5 Species recorded from digital aerial surveys from April to July 2012

Species	April	May	June	July	Sept	Dec	Feb
Arctic / Common Tern		3	3	2			
Auk / Small Gull	15					9	5
auk species	65	40	78	30	24	82	156
Basking Shark			1	1	5		
Big Bird			1		1		
Black Guillemot				2			
black-backed gull species	1					33	1
Black-headed Gull			4			1	1
Cetacean/Seal/Shark species					1		
Common Dolphin				2			
Common Gull		16	2	1	3		
Common Scoter			2				2
Cormorant		2			1		
Cormorant/Shag species					1		
diver species	6		1		2	26	3
duck species		2	3	1		16	
Eider	2	25	12				13
Fulmar	318	84	105	114	28	133	186
Fulmar / gull species	80	5	25	6	2	11	27
Fulmar / Small Gull (excluding Little Gull)	46		1		1	1	
Gannet	44	91	69	199	247	2	5
Great Black-backed Gull		1	1	1	1	2	11
Great Northern Diver	1						
Great Skua	4			1			
grey gull species (Herring or Common)			1				
Grey Seal			2	1	2		
Greylag Goose	2	10	3	16	122	1	5
Guillemot	35	1	3	13	11	2	1
gull species	3	1	1	1	1	27	8
Harbour Porpoise	6		15	5	2	2	1
Herring Gull	2	3	7	2	2	6	14
Iceland Gull	1						
Kittiwake	30	2	9	8	4	22	121
Large Auk	88	12	81	63	28	6	13
Large Auk / Throated Diver			2		1		
large gull (including Common)					1		
large gull species				1	3	17	5
Lesser black-backed Gull	1		1	3	2	9	1
Minke Whale			1				
Oystercatcher			1				
Puffin	10	22	32	15	1	2	5
Razorbill	6			4	3		

Species	April	May	June	July	Sept	Dec	Feb
Red-throated Diver			2	1	3	1	
Risso's Dolphin				4			
seal species	1		5	2	3		
Shag		1		1	1		
shearwater species				1			
shearwater species / auk species			1				
skua species				1			
Small Auk	7	1	2	3			2
Small Bird	17	3	6	14			1
Small Cetecean / Seal Species			1				
Small Gull (Excluding Little)	2					1	
small gull species	1	1	3				3
small wader species	1			1			
Tern (excluding little)			7				
Tern / Small Gull		1	1				
tern species		15	6	3			
Unidentified storm-petrel	3			15			
wader species		5	4				
White-beaked Dolphin	4			3			
Total	**803**	**347**	**516**	**541**	**507**	**412**	**590**

Table 6 - Estimates of bird species abundance in the study area. Values with coefficients of variation (%CVs) and lower and upper confidence intervals were estimated through design based analysis of encounter rate corrected for survey effort. [1]Where only one observation was recorded this was just multiplied by 10 to correct for 10% survey coverage. Individual diver and auk species abundances were also estimated using proportions of records that were identified to species in each survey[2]

Species/ Group	April			May			June			July		
	N(%CV)	LCI	UCI	N(%CV)	LCI	UCI	N(%CV)	LCI	UCI	N(%CV)	LCI	UCI
Eider	20(106)	3	117	244(70)	68	879	117(101)	21	642	0	-	-
Common Scoter	0	-	-	0	-	-	20(106)	3	116	0	-	-
diver species	69(48)	28	174	0	-	-	29(79)	7	121	10[1]	-	-
Red-throated Diver[2]	0	-	-	0	-	-	29	-	-	10	-	-
Great Northern Diver[2]	69	-	-	0	-	-	0	-	-	0	-	-
Fulmar	3161(26)	1887	5294	819(35)	408	1645	1024(35)	513	2046	1108(14)	836	1469
Gannet	426(32)	225	805	888(18)	620	1271	673(17)	481	941	1935(10)	1588	2358
Cormorant	0	-	-	20(78)	5	84	0	-	-	0	-	-
Shag	0	-	-	10[1]	-	-	0	-	-	10[1]	-	-
Great Skua	40(66)	12	134	0	-	-	0	-	-	10[1]	-	-
Kittiwake	297(35)	148	596	20(105)	3	115	88(49)	34	225	78(44)	33	181
Black-headed Gull	0	-	-	0	-	-	39(83)	9	169	0	-	-
Common Gull	0	-	-	156(49)	61	399	20(78)	5	84	10[1]	-	-
Lesser Black-backed Gull	10[1]	-	-	0	-	-	10[1]	-	-	29(63)	9	96
Herring Gull	20(106)	3	117	29(63)	9	96	68(44)	29	159	19(78)	5	83
Great Black-backed Gull	0	-	-	10[1]	-	-	10[1]	-	-	10[1]	-	-
all auks	2051(22)	1312	3205	741(25)	446	1234	1912(19)	1314	2783	1264(15)	934	1711
auk sp	674(22)	431	1054	390(28)	222	684	1073(20)	712	1618	418(21)	272	643
large auk sp	1258(24)	777	2039	127(36)	63	256	819(20)	543	1236	778(17)	548	1105
small auk sp	119(71)	32	435	224(38)	106	473	20(106)	3	116	68(56)	24	197
Guillemot[2]	1536	-	-	144	-	-	911	-	-	755	-	-
Razorbill[2]	263	-	-	0	-	-	0	-	-	232	-	-
Black Guillemot[2]	0	-	-	0	-	-	0	-	-	25	-	-

Species/ Group	April			May			June			July		
	N(%CV)	LCI	UCI	N(%CV)	LCI	UCI	N(%CV)	LCI	UCI	N(%CV)	LCI	UCI
Puffin[2]	251	-	-	597	-	-	1001	-	-	244	-	-

Species/ Group	September			December			February (2013)		
	N(%CV)	LCI	UCI	N(%CV)	LCI	UCI	N(%CV)	LCI	UCI
Eider	0	-	-	0	-	-	130(97)	25	672
Common Scoter	0	-	-	0	-	-	20(123)	2	181
diver species	50(79)	12	209	269(91)	56	1299	30(94)	5	169
Red-throated Diver	30(0.8)	6	158	0	-	-	0	-	-
Red-throated Diver[2]	50	-	-	0	-	-	0	-	-
Great Northern Diver[2]	0	-	-	0	-	-	0	-	-
Fulmar	279(42)	123	634	1324(33)	688	2548	1853(43)	799	4296
Gannet	2464(13)	1886	3219	20(99)	2	210	50(68)	14	182
Cormorant	0	-	-	0	-	-	0	-	-
Shag	0	-	-	0	-	-	0	-	-
Great Skua	0	-	-	0	-	-	0	-	-
Kittiwake	40(78)	9	173	219(38)	105	456	1206(24)	744	1953
Black-headed Gull	0	-	-	0	-	-	0	-	-
Common Gull	30(94)	5	169	0	-	-	0	-	-
Lesser Black-backed Gull	20(99)	2	212	90(85)	20	399	0	-	-
Herring Gull	20(99)	2	211	60(60)	19	191	139(46)	57	339
Great Black-backed Gull	0	-	-	20(99)	2	211	110(44)	47	256
all auks	668(23)	428	1043	916(21)	603	1391	1763(19)	1197	2597
auk sp	249(43)	109	570	816(22)	522	1275	1614(19)	1094	2380
large auk sp	419(25)	256	686	80(54)	28	223	130(57)	45	375
small auk sp	0	-	-	20(99)	2	211	20(122)	2	181
Guillemot	110(43)	47	254	20(99)	2	211	0	-	-
Razorbill	30(81)	6	158	0	-	-	0	-	-
Black Guillemot	0	-	-	0	-	-	0	-	-
Puffin	0	-	-	20(99)	2	211	50(109)	8	3002
Guillemot[2]	513	-	-	733	-	-	1175	-	-

Species/ Group	September			December			February (2013)		
	N(%CV)	LCI	UCI	N(%CV)	LCI	UCI	N(%CV)	LCI	UCI
Razorbill[2]	140	-	-	0	-	-	0	-	-
Black Guillemot[2]	0	-	-	0	-	-	0	-	-
Puffin[2]	16	-	-	183	-	-	588	-	-

Table 7 – Summary of number of birds counted from shore points. Birds flying through the count area were not counted except where indicated by an asterisk (*). Counts include birds seen on rocks and cliffs. The SIA and MEL shore points were counted on the day before that shown in June and September. 'n.c.' indicates that no count was made on that date (see Table 1). Shore point names are given in Table 1.

Species/Survey month	DAL	SSH	NSH	BRA	BRU	SHA	MEL	SGA	AIR	SWA	BLW	BLE	PON	Total
Red-throated diver														
April 2012	0	0	0	0	0	0	0	0	0	1	n.c.	0	0	**1**
May 2012	n.c.	0	0	0	n.c.	0	0	0	0	2	0	0	1	**3**
June 2012	n.c.	0	0	1	n.c.	0	0	0	3	0	0	0	0	**4**
July 2012	n.c.	n.c.	n.c.	1	n.c.	0	0	2	2	2	0	0	0	**7**
Sep. 2012	n.c.	0	0	0	n.c.	1	0	0	0	1	0	0	0	**2**
Dec. 2012	n.c.	n.c.	0	1	n.c.	n.c.	0	n.c.	1	1	n.c.	0	0	**3**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	0	1	0	**1**
Black-throated diver														
April 2012	0	0	0	0	0	0	0	0	0	0	n.c.	0	0	**0**
May 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
June 2012	n.c.	0	0	0	n.c.	0	0	0	0	1	0	0	0	**1**
July 2012	n.c.	n.c.	n.c.	0	n.c.	0	0	0	0	0	0	0	0	**0**
Sep. 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	n.c.	0	0	**0**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	0	0	0	**0**
Great northern diver														
April 2012	0	2	1	0	0	2	2	1	1	1	n.c.	0	0	**10**
May 2012	n.c.	3	4	4	n.c.	2	6	1	1	2	1	0	0	**24**
June 2012	n.c.	0	0	0	n.c.	0	0	0	2	1	0	1	0	**4**
July 2012	n.c.	n.c.	n.c.	2	n.c.	0	3	1	0	0	0	1*	0	**7**
Sep. 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
Dec. 2012	n.c.	n.c.	2	1	n.c.	n.c.	3	n.c.	2	1	n.c.	1	0	**10**

Species/Survey month	DAL	SSH	NSH	BRA	BRU	SHA	MEL	SGA	AIR	SWA	BLW	BLE	PON	Total
Feb. 2013	n.c.	n.c.	0	2	n.c.	n.c.	2	n.c.	0	1	0	0	0	**5**
Slavonian grebe														
April 2012	0	0	0	0	0	0	0	0	0	0	n.c.	0	0	**0**
May 2012	n.c.	0	0	2	n.c.	0	0	0	0	0	0	0	0	**2**
June 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
July 2012	n.c.	n.c.	n.c.	0	n.c.	0	0	0	0	0	0	0	0	**0**
Sep. 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	n.c.	0	0	**0**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	0	0	0	**0**
Fulmar														
April 2012	4	2	11	0	3	0	0	0	4	7	n.c.	3	15	**49**
May 2012	n.c.	1	8	0	n.c.	0	0	1	2	0	14	7	18	**51**
June 2012	n.c.	3	0	1	n.c.	2	2	1	0	0	20	19	39	**87**
July 2012	n.c.	n.c.	n.c.	0	n.c.	0	0	0	0	0	20	0	25	**45**
Sep. 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	21	n.c.	40	22	**83**
Feb. 2013	n.c.	n.c.	1	0	n.c.	n.c.	0	n.c.	0	6	112	69	242	**430**
Storm petrel														
April 2012	0	0	0	0	0	0	0	0	0	0	n.c.	0	0	**0**
May 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
June 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
July 2012	n.c.	n.c.	n.c.	0	n.c.	0	0	0	0	0	1	0	0	**1**
Sep. 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	n.c.	0	0	**0**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	0	0	0	**0**
Gannet														
April 2012	0	0	0	0	0	0	0	0	0	5	n.c.	1	0	**6**
May 2012	n.c.	4	0	0	n.c.	0	0	0	0	0	0	1	0	**5**

Species/Survey month	DAL	SSH	NSH	BRA	BRU	SHA	MEL	SGA	AIR	SWA	BLW	BLE	PON	Total
June 2012	n.c.	4	0	2	n.c.	0	0	1	3	5	2	3	6	**26**
July 2012	n.c.	n.c.	n.c.	0	n.c.	0	1	0	0	0	4	0	0	**5**
Sep. 2012	n.c.	0	0	0	n.c.	0	0	0	56	25	29	14	37	**161**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	n.c.	0	0	**0**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	1	0	0	0	0	**1**
Cormorant														
April 2012	0	0	0	0	0	0	0	0	0	0	n.c.	1	0	**1**
May 2012	n.c.	0	0	2	n.c.	0	0	0	0	0	0	0	0	**2**
June 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	2	0	**2**
July 2012	n.c.	n.c.	n.c.	0	n.c.	0	0	0	0	0	0	1	0	**1**
Sep. 2012	n.c.	0	0	2	n.c.	0	0	0	0	4	0	0	0	**6**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	n.c.	0	0	**0**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	0	0	0	**0**
Shag														
April 2012	1	0	1	1	0	2	0	0	0	0	n.c.	6	4	**15**
May 2012	n.c.	1	1	1	n.c.	0	0	0	0	2	2	2	9	**18**
June 2012	n.c.	0	2	1	n.c.	0	0	0	2	1	4	6	4	**20**
July 2012	n.c.	n.c.	n.c.	5	n.c.	0	2	0	6	27	4	11	11	**66**
Sep. 2012	n.c.	0	3	3	n.c.	1	0	0	1	53	28	4	6	**99**
Dec. 2012	n.c.	n.c.	3	3	n.c.	n.c.	1	n.c.	1	6	n.c.	10	2	**26**
Feb. 2013	n.c.	n.c.	2	4	n.c.	n.c.	5	n.c.	4	7	2	20	1	**45**
Eider														
April 2012	0	0	0	0	0	0	0	0	0	0	n.c.	0	0	**0**
May 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
June 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
July 2012	n.c.	n.c.	n.c.	0	n.c.	0	0	0	0	0	0	0	0	**0**
Sep. 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	62	n.c.	0	0	n.c.	0	0	**62**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	1	0	0	0	**1**

Species/Survey month	DAL	SSH	NSH	BRA	BRU	SHA	MEL	SGA	AIR	SWA	BLW	BLE	PON	Total
Red-breasted merganser														
April 2012	0	0	0	0	0	0	0	0	0	0	n.c.	0	0	**0**
May 2012	n.c.	0	0	10	n.c.	0	0	0	0	0	0	0	0	**10**
June 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
July 2012	n.c.	n.c.	n.c.	0	n.c.	0	0	0	0	0	0	0	0	**0**
Sep. 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	n.c.	0	0	**0**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	0	0	0	**0**
Arctic skua														
April 2012	0	0	0	0	0	0	0	0	0	0	n.c.	0	0	**0**
May 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
June 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	4	**4**
July 2012	n.c.	n.c.	n.c.	0	n.c.	0	0	0	0	0	0	1*	0	**1**
Sep. 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	n.c.	0	0	**0**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	0	0	0	**0**
Great skua														
April 2012	0	0	0	0	0	0	0	1	0	0	n.c.	0	0	**1**
May 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
June 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	2	0	0	**2**
July 2012	n.c.	n.c.	n.c.	0	n.c.	0	0	0	0	0	1	0	0	**1**
Sep. 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	n.c.	0	0	**0**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	0	0	0	**0**
Black-headed gull														
April 2012	0	0	24	36	0	0	3	0	0	2	n.c.	0	4	**69**
May 2012	n.c.	0	0	0	n.c.	0	0	0	0	2	0	0	0	**2**
June 2012	n.c.	0	2	0	n.c.	0	0	0	0	0	0	0	0	**2**

Species/Survey month	DAL	SSH	NSH	BRA	BRU	SHA	MEL	SGA	AIR	SWA	BLW	BLE	PON	Total
July 2012	n.c.	n.c.	n.c.	0	n.c.	0	0	0	0	0	0	0	0	**0**
Sep. 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	n.c.	0	0	**0**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	0	0	0	**0**
Common gull														
April 2012	0	2	57	46	2	0	88	0	0	1	n.c.	3	15	**214**
May 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
June 2012	n.c.	0	1	2	n.c.	0	0	0	5	0	0	0	0	**8**
July 2012	n.c.	n.c.	n.c.	0	n.c.	0	0	0	0	2	2	0	2	**6**
Sep. 2012	n.c.	0	1	0	n.c.	0	6	0	0	1	0	1	0	**9**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	1	2	n.c.	1	0	**4**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	0	0	0	**0**
Lesser black-backed gull														
April 2012	0	2	0	11	0	0	3	0	0	0	n.c.	3	0	**19**
May 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	2	0	**2**
June 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	9	0	**9**
July 2012	n.c.	n.c.	n.c.	0	n.c.	0	0	0	0	0	0	0	0	**0**
Sep. 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	n.c.	0	0	**0**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	0	0	0	**0**
Herring gull														
April 2012	0	22	4	4	0	0	0	0	0	0	n.c.	5	3	**38**
May 2012	n.c.	0	1	0	n.c.	3	0	0	0	0	0	37	0	**41**
June 2012	n.c.	0	0	0	n.c.	0	0	1	0	8	0	28	0	**37**
July 2012	n.c.	n.c.	n.c.	2	n.c.	0	0	0	0	0	0	12	2	**16**
Sep. 2012	n.c.	0	1	0	n.c.	0	0	0	0	13	3	0	0	**17**
Dec. 2012	n.c.	n.c.	10	0	n.c.	n.c.	6	n.c.	0	0	n.c.	17	0	**33**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	2	31	70	**103**

Species/Survey month	DAL	SSH	NSH	BRA	BRU	SHA	MEL	SGA	AIR	SWA	BLW	BLE	PON	Total
Iceland gull														
April 2012	0	0	0	1	0	0	0	0	0	0	n.c.	0	0	**1**
May 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
June 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
July 2012	n.c.	n.c.	n.c.	0	n.c.	0	0	0	0	0	0	0	0	**0**
Sep. 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	n.c.	0	0	**0**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	0	0	0	**0**
Great black-backed gull														
April 2012	0	0	0	0	0	0	0	1	1	0	n.c.	2	0	**4**
May 2012	n.c.	0	0	1	n.c.	0	0	0	0	0	0	3	0	**4**
June 2012	n.c.	0	0	0	n.c.	0	0	0	0	1	0	3	0	**4**
July 2012	n.c.	n.c.	n.c.	0	n.c.	0	0	0	0	0	0	4	0	**4**
Sep. 2012	n.c.	0	0	0	n.c.	0	0	0	0	5	0	8	0	**13**
Dec. 2012	n.c.	n.c.	4	0	n.c.	n.c.	2	n.c.	2	1	n.c.	8	1	**18**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	2	n.c.	2	1	1	3	1	**10**
Kittiwake														
April 2012	0	0	0	0	0	0	0	0	0	0	n.c.	0	0	**0**
May 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	3	0	12	**15**
June 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
July 2012	n.c.	n.c.	n.c.	0	n.c.	0	0	0	0	0	0	0	5	**5**
Sep. 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	2	n.c.	0	2	**4**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	1	n.c.	6	1	2	1	0	**11**
Common tern														
April 2012	0	0	0	0	0	0	0	0	0	0	n.c.	0	0	**0**
May 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
June 2012	n.c.	0	1	0	n.c.	0	0	0	0	0	0	0	0	**1**

Species/Survey month	DAL	SSH	NSH	BRA	BRU	SHA	MEL	SGA	AIR	SWA	BLW	BLE	PON	Total
July 2012	n.c.	n.c.	n.c.	0	n.c.	0	0	0	0	0	0	0	0	**0**
Sep. 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	n.c.	0	0	**0**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	0	0	0	**0**
Arctic tern														
April 2012	0	0	0	0	0	0	0	0	0	0	n.c.	0	0	**0**
May 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
June 2012	n.c.	0	4	1	n.c.	0	0	0	0	18	0	0	1	**24**
July 2012	n.c.	n.c.	n.c.	2	n.c.	0	0	1	1	0	0	0	0	**4**
Sep. 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	n.c.	0	0	**0**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	0	0	0	**0**
Guillemot														
April 2012	0	0	0	0	0	0	0	0	3	3	n.c.	0	4	**10**
May 2012	n.c.	1	0	0	n.c.	0	0	0	1	0	1	7	36	**46**
June 2012	n.c.	0	0	0	n.c.	5	0	0	4	4	5	49	68	**135**
July 2012	n.c.	n.c.	n.c.	0	n.c.	0	0	0	4	2	1	2	6	**15**
Sep. 2012	n.c.	0	1	0	n.c.	0	1	0	0	0	1	1	0	**4**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	1	n.c.	0	0	**1**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	0	0	45	**45**
Razorbill														
April 2012	0	0	0	0	0	0	0	0	0	5	n.c.	0	1	**6**
May 2012	n.c.	7	8	0	n.c.	2	2	0	0	5	4	3	1	**32**
June 2012	n.c.	0	2	0	n.c.	0	0	0	0	4	1	0	1	**8**
July 2012	n.c.	n.c.	n.c.	1	n.c.	0	0	0	4	5	0	0	0	**10**
Sep. 2012	n.c.	0	0	0	n.c.	0	0	0	0	3	0	0	0	**3**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	n.c.	0	0	**0**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	2	0	0	**2**

Species/Survey month	DAL	SSH	NSH	BRA	BRU	SHA	MEL	SGA	AIR	SWA	BLW	BLE	PON	Total
Unidentified guillemot/razorbill														
April 2012	0	0	0	0	0	1	0	0	1	3	n.c.	0	1	**6**
May 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	1	0	0	**1**
June 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	3	8	**11**
July 2012	n.c.	n.c.	n.c.	0	n.c.	0	0	1	0	0	0	0	0	**1**
Sep. 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	n.c.	0	0	**0**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	0	0	0	**0**
Black guillemot														
April 2012	0	2	0	0	1	1	1	0	0	0	n.c.	0	3	**8**
May 2012	n.c.	6	0	0	n.c.	0	0	0	0	1	7	0	2	**16**
June 2012	n.c.	1	0	0	n.c.	0	3	0	4	0	12	5	2	**27**
July 2012	n.c.	n.c.	n.c.	2	n.c.	3	1	1	1	5	10	1	5	**29**
Sep. 2012	n.c.	1	0	0	n.c.	0	0	0	0	0	0	0	0	**1**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	1	n.c.	1	1	n.c.	0	0	**3**
Feb. 2013	n.c.	n.c.	1	0	n.c.	n.c.	0	n.c.	0	0	0	0	0	**1**
Puffin														
April 2012	0	0	0	0	0	0	0	0	0	0	n.c.	0	0	**0**
May 2012	n.c.	4	0	0	n.c.	4	0	0	0	0	11	0	0	**19**
June 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	3	0	0	**3**
July 2012	n.c.	n.c.	n.c.	0	n.c.	0	0	0	0	0	0	0	0	**0**
Sep. 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	n.c.	0	0	**0**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	0	0	0	**0**

Table 8 - Summary of number of marine mammals and sharks counted from shore points. The SIA and MEL shore points were counted on the day before that shown in June and September. 'n.c.' indicates that no count was made on that date (see Table 1). Shore point names are given in Table 1

Species/Survey month	DAL	SSH	NSH	BRA	BRU	SHA	MEL	SGA	AIR	SWA	BLW	BLE	PON	Total
Grey seal														
April 2012	0	0	0	0	0	0	0	0	0	0	n.c.	0	0	**0**
May 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
June 2012	n.c.	0	0	0	n.c.	0	0	1	0	0	0	1	0	**2**
July 2012	n.c.	n.c.	n.c.	0	n.c.	0	2	0	0	0	1	0	1	**4**
Sep. 2012	n.c.	0	0	0	n.c.	0	0	0	0	8	0	0	0	**8**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	n.c.	0	0	**0**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	0	1	0	**1**
Unidentified dolphin sp.														
April 2012	0	0	0	0	0	0	0	0	0	0	n.c.	0	0	**0**
May 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
June 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	2	0	**2**
July 2012	n.c.	n.c.	n.c.	0	n.c.	0	0	0	0	0	0	0	0	**0**
Sep. 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	n.c.	0	0	**0**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	0	0	0	**0**
Harbour porpoise														
April 2012	0	0	0	0	0	0	0	0	0	0	n.c.	0	0	**0**
May 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
June 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	1	3	**4**
July 2012	n.c.	n.c.	n.c.	0	n.c.	0	0	0	0	0	1	0	0	**1**
Sep. 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	n.c.	0	0	**0**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	0	0	0	**0**

Species/Survey month	DAL	SSH	NSH	BRA	BRU	SHA	MEL	SGA	AIR	SWA	BLW	BLE	PON	Total
Basking shark														
April 2012	0	0	0	0	0	0	0	0	0	0	n.c.	0	0	**0**
May 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
June 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	0	**0**
July 2012	n.c.	n.c.	n.c.	0	n.c.	0	0	0	0	0	0	0	1	**1**
Sep. 2012	n.c.	0	0	0	n.c.	0	0	0	0	0	0	0	1	**1**
Dec. 2012	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	n.c.	0	0	**0**
Feb. 2013	n.c.	n.c.	0	0	n.c.	n.c.	0	n.c.	0	0	0	0	0	**0**

Table 9 - Loch Roag survey dates, sea state and weather conditions

Date	Time	Weather	Comment
28 April 2012	07:50-20:00	Sea state 0-1 becoming 1-2 by 14:00. 0-1 swell. Fine, mostly overcast.	Excellent survey conditions
5 June 2012	07:25-16:30	Sea state 0-1 becoming 2-3 by 15:00. No swell. Fine, overcast.	Excellent survey conditions
7 July 2012	14:00-17:30	Sea state 1. No swell. Fine, overcast.	Excellent survey conditions
8 July 2012	08:00-1230	Sea state 2, 0-0.5m swell, fine, partly overcast. Slow deterioration and by end sea-state 2-3, overcast and continuous rain and low cloud.	Excellent at start becoming good then poor. Survey visit abandoned due to onset of continuous rain and low cloud, which lasted rest of day.
27 July 2012	11:00-17:40	Sea state 1-2, 0-0.5m swell, fine, overcast. Prolonged heavy showers after 14:00	Very good conditions most of the time, good-poor conditions during showers. Survey work temporarily halted during worst of showers. Survey abandoned at 17:40 when rain and low cloud set in for rest of day. Survey work on Great Berneray only.
2 October 2012	08:20-17:40	Sea state 1-2, occasionally 3, 0 swell, mostly fine, partly overcast. Occasional short showers.	Excellent conditions most of the time, conditions reducing to very good or good at times due to showers. Survey work temporarily halted during worst of showers.
10 January 2012	09:10-15:51	Sea state 1-2, occasionally 3, Wind SSE 0-2, 0 swell, fine, overcast.	Excellent survey conditions. Western parts of survey area counted.
11 January 2012	09:15-15:51	Sea state 1-3, occasionally 4, Wind SW 1-3, 0 swell, fine, partly overcast.	Mix of good and excellent survey conditions depending on sea state. Eastern parts of survey area counted.
08 February 2013	08:35-16:32	Sea state 1-3, occasionally 4, Wind variable direction 1-2. Occ. light shower, overcast.	Mostly excellent survey conditions, reducing to Good conditions in showers. Western parts of survey area counted.
09 February 2013	08:33-15:51	Sea state 1-2 before 14:30, sea state 3 afterwards. Wind SE 2-3, 0 swell, fine, overcast.	Excellent survey conditions most of the time, becoming Good later. Eastern parts of survey area counted.

Table 10 - Summary of results for seabirds recorded in the Loch Roag survey area. These achieve close to complete coverage of Loch Roag, although some western part were not covered in July. Includes flying and sitting birds

Seabirds	April 2012	June 2012	July 2012	Oct. 2012	Jan 2013	Feb 2013	Total	Mean Ap. - July	Mean Oct. - Feb
Black-throated Diver	6	0	1	1	7	12	27	2.3	6.7
Great Northern Diver	44	9	1	1	80	95	230	18.0	58.7
Red-throated Diver	39	22	26	10	14	4	115	29.0	9.3
Slavonian Grebe	2	0	0	3	16	13	34	0.7	10.7
Little grebe	0	0	0	0	1	2	3	0.0	1.0
Black Guillemot	49	55	33	17	22	54	230	45.7	31.0
Guillemot	7	13	5	8	0	0	33	8.3	2.7
Razorbill	3	52	11	5	2	1	74	22.0	2.7
Guillemot/razorbill	0	8	0	0	0	0	8	2.7	0.0
Cormorant	2	4	32	18	29	29	114	12.7	25.3
Shag	38	36	25	118	139	181	537	33.0	146.0
Gannet	0	26	41	1	0	0	68	22.3	0.3
Fulmar	0	16	11	0	93	45	165	9.0	46.0
Manx Shearwater	0	0	3	0	0	0	3	1.0	0.0
Common Tern	0	33	6	0	0	0	39	13.0	0.0
Arctic Tern	0	9	47	0	0	0	56	18.7	0.0
‘commic’ Tern	0	0	9	0	0	0	9	3.0	0.0

Table 11 - Summary of results for gull and wildfowl species recorded in the Loch Roag survey area. The surveys achieve close to complete coverage of Loch Roag, although some western part were not covered in July. Includes flying and sitting birds

Gulls and wildfowl	April 2012	June 2012	July 2012	Oct. 2012	Jan 2013	Feb 2013
Black-headed Gull	2	0	7	5		
Common Gull	17	5	16	22	21	2
Herring Gull	41	116	72	41	37	39
Lesser Black-backed Gull	0	0	2	0	0	0
Great Black-backed Gull	6	16	16	12	15	13
Kittiwake	0	1	5	0	0	0
Glaucous Gull	0	1	0	0	0	0
Red-breasted Merganser	23	2	0	14	39	36
Eider	275	92	219	145	136	141
Common Scoter	5	1	0	0	0	2
Shelduck	2	2	2	0	0	0
Long-tailed duck	0	0	0	0	1	3
Goldeneye	0	0	0	0	0	5
Teal	0	0	3	6	11	0
Greylag Goose	9	24	126	0	7	29
Mallard	2	0	6	2	8	0

Table 12 - Summary of results for waders, heron and eagle recorded in the Loch Roag survey area. The surveys achieve close to complete coverage of Loch Roag, although some western part were not covered in July. Includes flying and sitting birds

Waders, heron, eagles	April 2012	June 2012	July 2012	Oct. 2012	Jan 2013	Feb 2013
Common Sandpiper	no count	no count	3	no count	no count	no count
Curlew	no count	no count	4	no count	no count	no count
Greenshank	no count	no count	5	no count	no count	no count
Lapwing	no count	no count	10	no count	no count	no count
Ringed Plover	no count	no count	2	no count	no count	no count
Grey Heron	no count	no count	11	no count	no count	no count
White-tailed eagle	0	0	0	0	1	0

Table 13 - Summary of results for marine mammals recorded in the Loch Roag survey area. The surveys achieve close to complete coverage of Loch Roag, although some western part were not covered in July. Includes flying and sitting birds

Marine mammals	April 2012	June 2012	July 2012	Oct. 2012	Jan 2013	Feb 2013
Common Seal	12	1	12	8	9	5
Grey Seal	0	1	0	3	1	83
Seal sp.	0	0	1	0	0	0

Table 14 - Red-throated diver: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	16	1	8	8	6	**39**
Jun-2012	13	5	1	3	0	**22**
Jul-2012	0	9	15	2	0	**26**
Oct-2012	3	1	5	1	0	**10**
Jan-2013	9	0	3	2	0	**14**
Feb-2013	1	1	1	0	1	**4**

Table 15 - Black-throated diver: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	2	0	0	2	2	6
Jun-2012	0	0	0	0	0	0
Jul-2012	0	0	0	1	0	1
Oct-2012	0	0	0	1	0	1
Jan-2013	7	0	0	0	0	7
Feb-2013	12	0	0	0	0	12

Table 16 - Great northern diver: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	4	23	17	0	0	44
Jun-2012	1	2	5	1	0	9
Jul-2012	0	0	1	0	0	1
Oct-2012	0	0	1	0	0	1
Jan-2013	25	22	31	2	0	80
Feb-2013	27	27	35	6	0	95

Table 17 - Little grebe: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	0	0	0	0	0	0
Jun-2012	0	0	0	0	0	0
Jul-2012	0	0	0	0	0	0
Oct-2012	0	0	0	0	0	0
Jan-2013	0	1	0	0	0	1
Feb-2013	0	1	1	0	0	2

Table 18 - Slavonian grebe: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	0	0	0	2	0	2
Jun-2012	0	0	0	0	0	0
Jul-2012	0	0	0	0	0	0
Oct-2012	2	0	1	0	0	3
Jan-2013	8	0	0	8	0	16
Feb-2013	5	1	0	6	1	13

Table 19 - Fulmar: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	0	0	0	0	0	0
Jun-2012	16	0	0	0	0	16
Jul-2012	0	10	1	0	0	11
Oct-2012	0	0	0	0	0	0
Jan-2013	93	0	0	0	0	93
Feb-2013	20	0	25	0	0	45

Table 20 - Manx shearwater: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	0	0	0	0	0	0
Jun-2012	0	0	0	0	0	0
Jul-2012	0	0	3	0	0	3
Oct-2012	0	0	0	0	0	0
Jan-2013	0	0	0	0	0	0
Feb-2013	0	0	0	0	0	0

Table 21 - Gannet: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	0	0	0	0	0	0
Jun-2012	25	0	1	0	0	26
Jul-2012	2	17	22	0	0	41
Oct-2012	1	0	0	0	0	1
Jan-2013	0	0	0	0	0	0
Feb-2013	0	0	0	0	0	0

Table 22 - Cormorant: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	1	0	0	0	1	2
Jun-2012	1	2	1	0	0	4
Jul-2012	0	4	7	4	0	15
Oct-2012	2	4	11	0	1	18
Jan-2013	12	5	12	0	0	29
Feb-2013	0	7	3	18	1	29

Table 23 - Shag: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	20	12	2	7	0	41
Jun-2012	21	13	2	0	0	36
Jul-2012	0	15	10	0	0	25
Oct-2012	75	16	20	6	1	118
Jan-2013	37	53	40	7	2	139
Feb-2013	64	31	36	45	5	181

Table 24 - Greylag Goose: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit. In addition, a total of 78 goslings were seen accompanying adults in July (*)

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	3	3	3	0	0	9
Jun-2012	4	0	3	17	0	24
Jul-2012	0	7*	14*	87*	19*	127
Oct-2012	0	0	0	0	0	0
Jan-2013	7	0	0	0	0	7
Feb-2013	4	25	0	0	0	29

Table 25 - Shelduck: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	0	0	0	2	0	2
Jun-2012	0	0	0	2	0	2
Jul-2012	0	0	0	2	0	2
Oct-2012	0	0	0	0	0	0
Jan-2013	0	0	0	0	0	0
Feb-2013	0	0	0	0	0	0

Table 26 - Teal: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	0	0	0	0	0	0
Jun-2012	0	0	0	0	0	0
Jul-2012	0	0	3	0	0	3
Oct-2012	0	0	0	6	0	6
Jan-2013	0	0	0	0	11	11
Feb-2013	0	0	0	0	0	0

Table 27 - Mallard: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	0	0	0	2	0	2
Jun-2012	0	0	0	0	0	0
Jul-2012	0	2	0	4	0	6
Oct-2012	0	0	0	2	0	2
Jan-2013	0	0	0	0	8	8
Feb-2013	0	0	0	0	0	0

Table 28 - Eider: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit. In addition, a total of 12 ducklings were seen accompanying adults in July (*)

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	198	77	0	0	0	275
Jun-2012	59	33	0	0	0	92
Jul-2012	0	203*	16*	0	0	219
Oct-2012	137	4	1	3	0	145
Jan-2013	136	0	0	0	0	136
Feb-2013	140	1	0	0	0	141

Table 29 - Long-tailed duck: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	0	0	0	0	0	0
Jun-2012	0	0	0	0	0	0
Jul-2012	0	0	0	0	0	0
Oct-2012	0	0	0	0	0	0
Jan-2013	0	0	0	1	0	1
Feb-2013	0	2	0	1	0	3

Table 30 - Common scoter: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	5	0	0	0	0	5
Jun-2012	0	0	1	0	0	1
Jul-2012	0	0	0	0	0	0
Oct-2012	0	0	0	0	0	0
Jan-2013	0	0	0	0	0	0
Feb-2013	2	0	0	0	0	2

Table 31 - Goldeneye: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	0	0	0	0	0	0
Jun-2012	0	0	0	0	0	0
Jul-2012	0	0	0	0	0	0
Oct-2012	0	0	0	0	0	0
Jan-2013	0	0	0	0	0	0
Feb-2013	0	4	0	1	0	5

Table 32 - Red-breasted merganser: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	0	0	0	19	4	23
Jun-2012	0	0	0	1	1	2
Jul-2012	0	0	0	0	0	0
Oct-2012	0	0	0	12	2	14
Jan-2013	2	8	5	18	6	39
Feb-2013	0	18	7	5	6	36

Table 33 - Black-headed gull: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	1	0	0	1	0	2
Jun-2012	0	0	0	0	0	0
Jul-2012	0	0	0	7	0	7
Oct-2012	4	0	0	1	0	5
Jan-2013	0	0	0	0	0	0
Feb-2013	0	0	0	0	0	0

Table 34 - Common gull: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	3	1	13	0	0	17
Jun-2012	1	0	2	0	2	5
Jul-2012	0	0	4	7	2	13
Oct-2012	11	3	2	6	0	22
Jan-2013	2	3	1	15	0	21
Feb-2013	2	0	0	0	0	2

Table 35 - Lesser black-backed gull: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	0	0	0	0	0	0
Jun-2012	0	0	0	0	0	0
Jul-2012	0	0	1	1	0	2
Oct-2012	0	0	0	0	0	0
Jan-2013	0	0	0	0	0	0
Feb-2013	0	0	0	0	0	0

Table 36 - Herring gull: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	19	15	1	6	0	41
Jun-2012	74	37	0	0	5	116
Jul-2012	4	50	9	5	4	72
Oct-2012	11	7	13	7	3	41
Jan-2013	22	12	1	1	1	37
Feb-2013	8	1	28	2	0	39

Table 37 - Glaucous gull: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	0	0	0	0	0	0
Jun-2012	0	1	0	0	0	1
Jul-2012	0	0	0	0	0	0
Oct-2012	0	0	0	0	0	0
Jan-2013	0	0	0	0	0	0
Feb-2013	0	0	0	0	0	0

Table 38 - Great black-backed gull: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	4	0	1	1	0	6
Jun-2012	2	13	0	1	0	16
Jul-2012	2	1	5	4	0	12
Oct-2012	4	0	5	3	0	12
Jan-2013	8	1	4	2	0	15
Feb-2013	3	1	6	3	0	13

Table 39 - Kittiwake: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	0	0	0	0	0	0
Jun-2012	1	0	0	0	0	1
Jul-2012	0	3	2	0	0	5
Oct-2012	0	0	0	0	0	0
Jan-2013	0	0	0	0	0	0
Feb-2013	0	0	0	0	0	0

Table 40 - Common tern: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit. In addition, nine unidentified 'commic' terns were recorded in July (*)

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	0	0	0	0	0	0
Jun-2012	0	0	30	2	1	33
Jul-2012	0	0*	1*	5	0	6
Oct-2012	0	0	0	0	0	0
Jan-2013	0	0	0	0	0	0
Feb-2013	0	0	0	0	0	0

Table 41 - Arctic tern: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit. In addition, nine unidentified 'commic' terns were recorded in July (*)

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	0	0	0	0	0	0
Jun-2012	7	0	0	2	0	9
Jul-2012	2	16*	16*	13	0	47
Oct-2012	0	0	0	0	0	0
Jan-2013	0	0	0	0	0	0
Feb-2013	0	0	0	0	0	0

Table 42 - Common guillemot: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit. In addition, eight unidentified guillemot/razorbill were recorded in June (*)

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	0	2	3	2	0	7
Jun-2012	7*	4	2	0	0	13
Jul-2012	0	1	5	0	0	6
Oct-2012	2	0	5	1	0	8
Jan-2013	0	0	0	0	0	0
Feb-2013	0	0	0	0	0	0

Table 43 - Razorbill: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit. In addition, eight unidentified guillemot/razorbill were recorded in June (*), and a total of five chicks were seen accompanying adults in July (**)

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	1	2	0	0	0	3
Jun-2012	10	39	3	0	0	52
Jul-2012	0	6**	5**	0	0	11
Oct-2012	1	0	4	0	0	5

Jan-2013	0	0	0	2	0	2
Feb-2013	0	1	0	0	0	1

Table 44 - Black guillemot: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	22	2	14	11	0	49
Jun-2012	32	3	7	13	0	55
Jul-2012	0	12	13	7	0	32
Oct-2012	9	1	6	1	0	17
Jan-2013	9	4	1	8	0	22
Feb-2013	22	16	9	7	0	54

Table 45 - Common seal: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit. In addition, a single unidentified seal was recorded in July (*)

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	0	0	0	8	4	12
Jun-2012	0	1	0	0	0	1
Jul-2012	0	0*	1	11	0	12
Oct-2012	0	0	1	7	0	8
Jan-2013	2	0	0	5	2	9
Feb-2013	0	1	0	3	1	5

Table 46 - Grey seal: the number of birds recorded in each sub-section of the Loch Roag survey area on each visit. In addition, a single unidentified seal was recorded in July (*)

Month	Kyles Pabay & Valtos	West Great Bernera	East Loch Roag	Lochs Barraglom & Hulavig	Little Loch Roag	Whole survey area
Apr-2012	0	0	0	0	0	0
Jun-2012	0	1	0	0	0	1
Jul-2012	0	0*	0	0	0	0
Oct-2012	1	0	1	1	0	3
Jan-2013	0	0	1	0	0	1
Feb-2013	0	80	3	0	0	83

Table 47 – Abundance (N) and density estimates with %CV and 95% confidence levels obtained from density surface modelling of the most commonly recorded species and species groups from the digital aerial surveys. The GAM model used was N ~ s(x, y, k = 10) + offset, Family = Negative binomial, Theta = 0.166, gamma=1.4. with automatic smooth selection by REML. n is the number of segments in the survey. k was set to 10 and gamma 1.4 to reduce the likelihood of overfitting. Where the estimated degrees of freedom (edf) approached 9 (k-1) conventionally k might be increased to reduce residuals however, this was maximum k and was fixed. The adjusted r-squared (r-sq) is the proportion of variance explained as a goodness of fit, Chi squared (Chi.sq) the test statistic and the p-value the probability of the null hypothesis that the model parameter is zero being true. * = significant at <0.001 level '*' significant at 0.05 level, '.' at the 0.1 level. The REML score is used in automatic smooth selection. Note that some models, such as gannets in May '12 had low significance and % deviance explained due to birds being more randomly distributed with only weak patterns in *x* and *y***

Survey	Species	n	edf	r-sq	Chi.sq	p-value	REML score	% Deviance explained	Density birds km^{-2}	N	% CV	LCL	UCL
Apr '12	Fulmar	499	7.427	0.0403	85.15	<2e-16 ***	371.11	36.5	3.203	**3197**	23.50	1725	4669
	Gannet	499	4.436	0.0317	21.83	3.53e-05 ***	129.19	24.3	0.416	**415**	26.57	199	631
	auks	499	4.041	0.0577	29.09	1.79e-07 ***	377.01	15.4	2.081	**2077**	20.92	1225	2929
May '12	Fulmar	504	5.255	-0.295	56.48	1.47e-12 ***	162.8	39.1	1.161	**1159**	29.66	485	1833
	Gannet	504	0.0003054	0.00139	0	0.558	250.78	0.000208	0.934	**932**	16.11	638	1226
	auks	504	4.726	0.0584	39.27	6.1e-09 ***	183.37	32.7	0.761	**760**	25.31	383	1137
Jun '12	Fulmar	505	6.006	0.03	45.99	1.09e-09 ***	202.18	33	0.978	**976**	26.43	470	1482
	Gannet	505	6.968	0.0446	24.9	0.000316 ***	193.21	24.5	0.685	**684**	24.07	361	1007
	auks	505	5.307	0.074	22.09	0.000115 ***	359.3	12.7	1.817	**1813**	20.48	1085	2541
Jul '12	Fulmar	505	1.804	0.0311	10.17	<2e-16 ***	292.77	6.85	1.123	**1121**	17.52	736	1506
	Gannet	505	1.329	0.00964	5.018	0.0285 *	427.46	2.81	2.039	**2035**	26.89	963	3107
	auks	505	0.02529	-0.00229	0.025	0.362	297.44	0.0238	1.351	**1348**	20.25	813	1883
Sept '12	Fulmar	511	3.145	0.0209	17.93	0.000119 ***	94.137	22.4	0.303	**302**	29.85	125	479
	Gannet	511	0.5967	0.00222	1.216	0.142	474.1	0.811	2.576	**2571**	15.21	1805	3337
	auks	511	2.205	0.0112	5.226	0.0504.	199.19	4.97	0.677	**676**	29.62	284	1068
Dec '12	Fulmar	508	5.662	0.0211	24.23	5.94e-05 ***	259.42	13.4	1.298	**1295**	21.38	752	1838

Survey	Species	n	edf	r-sq	Chi.sq	p-value	REML score	% Deviance explained	Density birds km^{-2}	N	% CV	LCL	UCL
	Gannet	508	2.665	0.12	2.816	0.363	9.9752	70.5	0.020	**20**	91.13	0	56
	auks	508	3.239	0.0383	16.85	0.000147 ***	234.19	11.9	0.889	**887**	29.32	377	1397
Feb '13	Fulmar	507	6.153	0.0685	60.03	1.42e-12 ***	221.36	38.3	1.693	**1690**	28.70	739	2641
	Gannet	507	1.334	0.0157	5.791	0.015 *	22.873	32.5	0.050	**50**	50.27	1	99
	auks	507	3.056	0.0441	16.6	0.000117 ***	368.29	8.92	1.768	**1765**	27.66	808	2722

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